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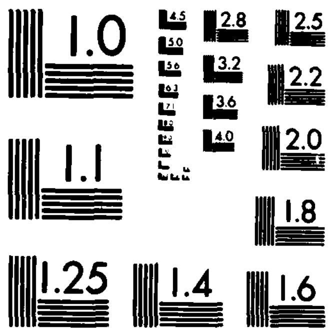

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Final Technical Report
January 1983

STUDY OF THE CAUSES OF UNNECESSARY REMOVALS OF AVIONIC EQUIPMENT

Hughes Aircraft Company

H. D. Rue and R. O. Lorenz

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This study investigated and verified the causes of unnecessary removals of suspect items from selected avionic equipment. During the study, the selected equipment average unnecessary removal rate was found to be 32.7% ~~percent~~ of all removals. The study report contains conclusions and recommendations useful in minimizing unnecessary removals.

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PREFACE

This report was performed for Rome Air Development Center (RADC) under Contract F30602-79-C-0200, and prepared in accordance with CDRL Item A002. The study was accomplished by the Design Effectiveness Operations organization of the Electro-Optical and Data Systems Group of the Hughes Aircraft Company, Culver City, California.

Mr. Jerry F. Lipa (RADC/RBET) was the RADC project engineer. Mr. R. O. Lorenz was the Hughes program manager, and Mr. H. D. Rue was the principal investigator. Messrs. M. H. Cochran, K. D. Morgan, R. A. Johnston and H. D. Rue accomplished the field survey tasks.

The methods developed for compiling and analyzing the baseline Air Force maintenance data records are attributable to Mr. G. A. Kern, and analyzing base level and depot level data records is attributable to Messrs. M. H. Cochran and K. D. Morgan. Other Hughes personnel who provided assistance and consultation during this study were Messrs. R. A. Gibson, E. Gulian, E. C. Hamilton, Jr., G. A. Heckmann, A. L. Lena, J. G. Malcolm, I. Quart, A. H. Samuels and K. L. Wong; and Mmes. S. M. Moite and M. E. Riehle.

Grateful acknowledgement is accorded the Deputy Commander for Maintenance (DCM) at each Air Force base visited by the Hughes field survey team, and to all Air Force and Contractor personnel, at field repair sites and depots, whose advice and assistance made possible the completion of this study.

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EXECUTIVE SUMMARY

Objectives

The objectives of this study are the determination of the (1) causes of unnecessary removal of avionic equipment, and (2) feasible means for minimizing such removals.

Definition

"Unnecessary removals" refers to the removal from aircraft platforms of those equipments that have no apparent defect in them when corrective maintenance is attempted at a repair facility. In this definition, the words "apparent defect" include cases wherein equipments may contain hidden faults. For example, an equipment may experience an in-flight environmental malfunction (e.g., component high-temperature sensitivity) which cannot be duplicated during subsequent ground-maintenance testing.

Approach

A field survey was conducted at twelve Air Force bases and three Air Force maintenance depots. The survey involved six selected avionic equipments on ten different aircraft platforms. The field survey team recorded their findings relative to each AFB visited. The team also collected calendar year (CY) 1979 maintenance data records which are analyzed herein. The field survey was conducted during the period of November 1979 to April 1980.

A CY 1978 field maintenance data base was established, using standard CONUS Air Force maintenance data collection (MDC) system elements combined with special data analysis methods and corollary software developed by Hughes. These data supplement the efforts of the field survey team. The major objective of this data base analysis was to determine the quantitative aspects of unnecessary removal (UR) events, at various levels of field maintenance. Those aspects relate to the six selected equipments on different aircraft platforms (including those observed by the field survey team).

The analyses in this study involve the observations of the field survey team, the Air Force maintenance data collection system, and review of related literature.

Key Findings

In this study, nine causes of URs were found. In the following listing, the causes are ranked in descending order, as to percentage of UR occurrences (CY 1979 maintenance data records):

1. Ineffective Built-in-Test (22 percent)
2. Ineffective or Missing Test Equipment (18 percent)
3. Ineffective Supervision/Support (16 percent)
4. Ineffective Technical Orders (13 percent)
5. Inaccessibility (12 percent)
6. Management Directives (7 percent)
7. Test Equipment Differences (7 percent)
8. Inadequate Skill (5 percent)
9. Inadequate Feedback (1 percent)

These causes encompass the "diagnostic elements" (i.e., human and machine factors) of avionic equipment maintenance technology.

The average UR rate (1978) was found to be 32.7 percent of all removals. In the opinion of the study team, a maximum UR rate of about 10 percent may be acceptable to most people.

This study found that flightline "nonstandard" troubleshooting practices by avionic technicians adversely affect the UR rate at some Air Force bases (AFBs). Such practices involve "shotgun" fault isolation, and "trial-and-error" or "substitution" by removal and replacement of suspect avionic equipment. Many of the causes of URs are related to nonstandard troubleshooting practices. For example, "Ineffective Built-in-Test (BIT)" is shown in the above listing as a major cause of URs. This cause of URs can develop a lack of confidence in BIT by maintenance personnel, who then resort to nonstandard troubleshooting to fault isolate a reported malfunction.

On the other hand, nonstandard troubleshooting may exist due to some AFB operating necessity. For example, some AFB missions may require high utilization of available aircraft (i.e., quick turnaround time), which can preclude standard troubleshooting procedures. In addition, there is the possibility that maintenance technicians have tried prescribed troubleshooting procedures

but found them unsatisfactory for certain maintenance actions. Nevertheless, nonstandard troubleshooting can adversely impact the UR rate.

Considerable variability of the UR problem from AFB-to-AFB, as well as URs involving the same equipment on different aircraft platforms, was found during comparison analyses. For example, at AFB "C" the APG-63 (RDP) on the F-15A aircraft experienced a UR rate of 76 percent, but at AFB "G" the same type equipment on the same type aircraft experienced a UR rate of 37 percent. An example of the variability involving the same type equipment on different aircraft is the ARN-118, which on eight different aircraft platforms at 11 AFBs experienced a range of UR rates from 80 to zero percent.

In general, a higher UR rate is experienced by attack, fighter and trainer aircraft compared with bomber and cargo aircraft. The difference in UR rates may be the result of the more rigorous mission environment of the attack, fighter and trainer aircraft. This difference may also relate to the effect of dissimilar maintenance policies at various AFBs.

The six selected equipments vary as to usage in service and degree of complexity. An analysis of equipment usage and complexity aspects of URs was designed to ascertain whether or not URs are a function of such aspects. The analysis was based on a comparison of frequency distribution histograms which were constructed from data in an inventory of selected aircraft/equipment combinations. The histograms involved "quantity of URs", "quantity of URs per 1000 flight hours" (usage factors), and "quantity of URs per million part hours during flight" (complexity factors). A comparison of these histograms led to the conclusion that URs are not a function of equipment usage or complexity.

In this study, an analysis of maintenance cost factors found that the average manhour cost of a UR is about six hours. However, the associated hidden costs (e.g., additional avionic spares, delays in test and repair of faulty equipment, creating equipment malfunctions during UR activities) can substantially increase the total average cost of URs.

Some findings in this study involve known problems. In such cases, the discussion is directed towards emphasis regarding the need for specific corrective action to reduce UR rates. For example, the known elements which must exist if maintenance activity is to be efficient are: skilled management,

personnel motivation and training, and effective diagnostic tools. The "emphasis", in this example, could be based on the fact that if any of the noted elements are missing or deficient, an inevitable result will be a problem involving URs.

Feasible Corrective Actions

Recommendations for minimizing the adverse effects of the three most frequently occurring causes of URs (56 percent) are as follows.

- Techniques for minimizing "Ineffective BIT" as a cause of URs should involve requirements for (1) fault isolation to a single LRU at flightline and a single SRU at repair shop (e.g., BIT detectors - microprocessors - at LRU interfaces), (2) commonality of maintenance testing (e.g., use of "identical" in-flight BIT malfunction data and conditions during flightline, repair shop and depot troubleshooting), (3) flexibility of BIT tolerances (e.g., capability for tightening tolerances during ground-BIT troubleshooting), (4) warrantable false alarm rates and BIT-related UR rates (e.g., establishing conditions similar to RIW contracts), and (5) closed-loop BIT data collection (e.g., developing a system to fully record BIT field experiences and evaluate specified BIT parameters).
- Techniques for minimizing "Ineffective or Missing Test Equipment" as a cause of URs should involve requirements for (1) special joint reviews by contractor and user personnel of specific test equipment known to be ineffective (not used as required) or missing at repair sites (e.g., developing a procedure whereby pertinent information from established Air Force audits and personnel-suggestions documents are reviewed to determine quick-response actions for T.O. revision, test equipment modification, or acquisition of needed cost-effective test equipment), (2) specifying alternative test-start points in T.O.s for more effective use of test equipment (e.g., certain fault-isolation tests can sometimes be quickly and cost effectively completed by starting the test at some midpoint in the T.O. procedure -- rather than always starting the test at the beginning of the T.O., as specified), and (3) specifying that new test equipment acquisition feature ease of transportation, ease in setup, fast maintenance test time, self-test capability, and commonality with test equipment used at all levels of maintenance.
- Techniques for minimizing "Ineffective Supervision/Support" as a cause of URs should involve requirements for (1) more stringent personnel control methods (e.g., nonstandard troubleshooting methods are sometimes the result of poor personnel habits which can be corrected by appropriate supervision control), (2) ensuring effective feedback of maintenance information from I-level shops to O-level personnel (e.g., the maintenance tasks of O-level personnel can be relieved if they become knowledgeable about the outcome of their

decision to send avionic equipment to I-level repair shops), (3) accurate documentation of maintenance actions at all levels (e.g., maintenance management visibility of problems is enhanced when accurate data is analyzed and reviewed), and (4) single supervision responsibility for both O-level and I-level maintenance functions (e.g., one supervisor can more effectively assign I-level specialists to assist O-level personnel with specific, urgent problems).

Future Studies

- The Air Force should initiate an in-depth study into the problem of nonstandard troubleshooting practices. For example, two squadrons (experiencing high UR rates) could be singled out for a time-limited experiment (e.g., three months). During this period, it would be mandatory that all maintenance will be performed "by the book." BIT instructions would be explicitly followed, Technical Orders would be rigorously followed, and prescribed test equipment would be utilized at organizational and intermediate levels. Care would be taken to keep accurate data records. This study would be different from previous AFB studies insofar that all pertinent, formal Air Force maintenance documents (procedures) would be rigorously pursued (i.e., variant local directives could be temporarily suspended).

  If the results of the experiment indicate a dramatic improvement in maintenance efficiency, then the Air Force would have confidence that the problem of URs could be greatly reduced by training maintenance personnel to abide by standard maintenance procedures. (In this case, the fundamental *problem* may be a "people problem.")

  If the results indicated deficiencies in the diagnostic tools (e.g., BIT, ATE) provided to maintenance personnel, the Air Force should take appropriate steps to improve the tools. (In this case, the fundamental problem may be a "hardware problem.")

  If the results were inconclusive, this would indicate the need for more fundamental studies into ways to improve maintenance effectiveness. Such studies could include determination of ways for improving communications and other human factor areas, or ways to identify the need for additional types of test equipment (e.g., flightline suitcase testers to supplement BIT).

- The Air Force should initiate a study into the area of detecting and isolating hidden faults (e.g., environmentally sensitive components). The investigation of such problems was beyond the scope of this study. Although some studies have already been performed into the feasibility of using small environmental chambers at the intermediate level of maintenance, more study is needed. The objective would be to develop simple environmental tests for exposing suspect avionic equipment to the environmental stresses experienced during aircraft missions.

1.0 INTRODUCTION

Reports generated by both commercial and military sources indicate that as much as 40 percent of the avionic equipments are unnecessarily removed from aircraft during maintenance activities. The suspected failures within these equipments cannot be verified either in the base repair shop or depot test facility. The reasons for such unnecessary maintenance activity have been attributed, with little evidence, to the (1) inability to reproduce the actual use environments, (2) presence of intermittent failures, or (3) inability of Built-In-Test (BIT) or external test subsystems to correctly detect and/or isolate a failure. Whatever the reason(s), significant logistic support resources are being wasted due to such unnecessary removals. Also, there is a decrease in the equipment's availability caused by the time expended on unneeded maintenance. Worse yet, while performing such needless maintenance on the equipment, the chances of inducing a failure increase substantially.

The objectives of this study are to (1) ascertain the actual causes for the needless removal of (supposedly) failed avionic equipment, and (2) determine feasible means for minimizing such needless removals while not adversely affecting the basic mission effectiveness of the aircraft which depend on such equipment. The attainment of these objectives involved analysis of field survey reports, Air Force maintenance data collection records, and review of avionic maintenance and reliability literature.

Unnecessary Removals (URs) refer to the removal from aircraft platforms of those equipments that have no apparent defect in them when corrective maintenance is attempted at a repair facility. This definition does not preclude the possibility (discussed herein) that a UR may have one or more "hidden faults" which may only be discernible under actual or simulated operational environmental conditions.

The words "Unnecessary Removal (UR)" signify the same condition as described by the words "Bench Checked - Serviceable (BCS)," "Cannot Duplicate (CND)," and "Retest OK (RTOK)" used in related studies. Semantical differences were not permitted to detract from the central issue in this study, namely, "what are the causes of such needless maintenance expenditures and how can they be minimized?"

The data used in this study are based on available historical data pertaining to maintenance actions involving selected avionic equipment. These data were obtained by the field survey team as well as from in-house computer files of Air Force maintenance data collection systems.

The factors which were considered in selecting and using data fall into three categories: type, quantity and quality. The type of data used depends upon the maintenance parameter of interest, namely: organizational level maintenance removals of avionic equipment and intermediate level maintenance bench checks. Quantity considerations relate to the amount of data needed for making meaningful calculations of UR occurrences, with a reasonable degree of confidence. Quality is of concern because in analyzing the data, numerous criteria must be satisfied in each area of interest.

The quality of data obtained varied widely relative to study needs, thereby imposing some limitations on the number of factors investigated. Also, data on some of the desired factors were unavailable and consequently those factors could not be included in the final analysis. Nevertheless, all factors on which good data were available were included for subsequent analyses.

The CY 1978 field maintenance data were derived from AFLC Regulation 66-1: Maintenance Data Collection System (Ref. 1), AFLC Regulation 66-15: Product Performance (Ref. 2), and AFLC Regulation 400-49: Weapon System Effectiveness (Ref. 3). These data elements were combined with special maintenance data analysis methods and corollary software developed by Hughes in support of two previous studies for RADC (Refs. 4 and 5). AFLC Regulation 66-1 and AFLC Regulation 66-15 were previously designated as AFM 66-1 and AFM 66-15, respectively, in the latter reports. The CY 1979 field maintenance data records were obtained by the field survey team from Base Level Inquiry System (BLIS) computer files at each of the designated Air Force bases.

The assessment of field maintenance characteristics of the selected equipments included the collection, review and analysis of on-equipment and off-equipment maintenance records. "On-equipment" identifies maintenance actions accomplished on complete end items of equipment (e.g., aircraft) or repairs accomplished on components in the same maintenance area as the end item. "Off-equipment" identifies support shop maintenance actions performed on removed components.

In this study, some findings involve known problems. Nevertheless, those problems are discussed in order to emphasize the need for new procedures or corrective actions to eliminate or minimize pertinent causes of URs.

2.0 STUDY PLAN

2.1 GENERAL

The Study of the Causes of Unnecessary Removals of Avionic Equipment (SCURAE) was accomplished by (1) conducting a field survey of several Air Force base and depot maintenance facilities; (2) establishing a field maintenance data base; and (3) analyzing the accumulated survey observations and reports, maintenance data, and related literature. Causes of unnecessary removals were identified, and procedures for minimizing the occurrence of these causes were investigated. These study efforts are graphically depicted in Figure 1.

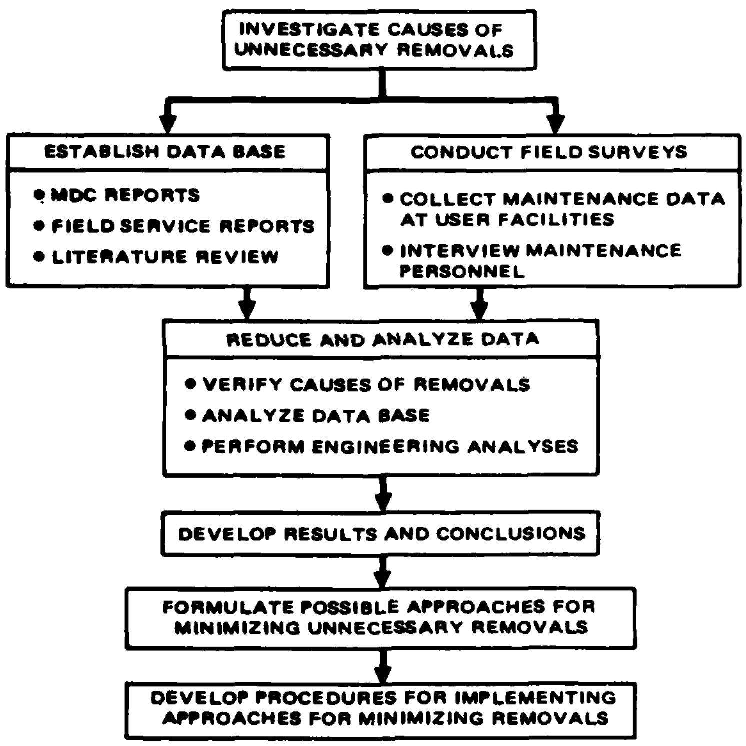

Figure 1. Study flow diagram.

2.2 AVIONIC EQUIPMENT

Based on a large data base compiled from previous studies (Refs. 4 and 5), a matrix (Table 1) of candidate equipments and associated aircraft platforms was formulated for consideration in this study. The equipment met the following criteria:

1. Equipment should include new avionic technology (e.g., solid state components, digital circuitry).

TABLE 1. EQUIPMENT SELECTION MATRIX

AIRCRAFT PLATFORM TYPE AND DESIGNATOR	ATTACK		FIGHTER/INTERCEPTOR										BOMBER				TRANSPORT					TRAINER		
EQUIPMENT DESIGNATOR	A-7D	A-10A	F-4E	F-5E	F-15A	F-100	F-101	F-106	F-111A	F-111D	F-111E	F-111F	FB-111A	B-52D	B-52G	B-52H	C-5A	C-130	C-135	KC-135	C-141	T-37	T-38	T-39
ASN-90 INERTIAL NAVIGATION	X																	X						
ARC-109 UHF RADIO					X			X	X	X	X	X	X				X							
ARC-164 UHF RADIO	X	X	X	X	P	X	X	P	P	P	P	P	P	X	X	X	P	X	X	X	X	X	X	X
ARN-58 GLIDE SLOPE/LOC RCVR	X								X	X	X	X	X							X			X	
ARN-84V TACAN SET				X								X	X											
ARN-118 TACAN SET	X	X	X		P		P		X	X	X			X	X	X		X	X	X	X	X	X	X
ARA-50 ADF SET	X								X	X		X						X						
URT-26 RADIO BEACON SET			X					X						X	X	X	X		X	X	X			
CAROUSEL IV INS																	X		X	X	X			
AJN-16 INS										X		X	X											
LN-16 SIDS																		X	X	X				
ASN-129 AHARS		X																			X			
APN-81 DOPPLER RADAR															X			X	X					
APN-167 RADAR ALTIMETER									X	X	X	X	X											
APQ-128/134 TF RADAR										X		X	X											
APX-64 IFF XPDR									X	X	X	X	X	X	X	X		X	X	X			X	
APX-72 IFF XPDR	X			X														X				X		
MARK XII IFF COMPUTER	X		X																					
AYK-6 COMPUTER										X		X	X											
CADC (AIR DATA COMPUTER)									X	X	X	X	X											
APX 101 IFF					X																			
AN/APG-63 RADAR (RDP)					X																			

LEGEND: X = EQUIPMENT CURRENTLY INSTALLED ON DESIGNATED AIRCRAFT PLATFORM
P = EQUIPMENT RETROFIT PLANNED ON DESIGNATED AIRCRAFT PLATFORM (1978)

2. Equipment should be common to several types of aircraft (e.g., fighters, bombers, trainers).

3. Equipment should be representative of diverse avionic functional areas (e.g., communication, navigation, radar).

From the matrix, specific equipments and aircraft platforms were selected for this study during the first technical coordination meeting convened by RADC at Wright-Patterson AFB (WPAFB) and attended by RADC, ASD/WPAFB, PRAM/WPAFB, and Hughes representatives. The selection of equipments to be studied entailed consideration of equipment (1) used on several aircraft platform types (e.g., AN/ASN-118, AN/ARC-164), (2) related to diverse avionic functional areas (e.g., AN/ASN-90, AN/APX-101, AN/APN-167) and installed on the several aircraft platforms, (3) representative of new digital processing techniques (e.g., AN/APG-63 Radar Data Processor), and (4) with related maintenance data available in Hughes computer files.

The technical coordination meeting attendees also selected the Air Force base (AFB) and depot maintenance facilities to be visited by the field survey team. Specific maintenance facilities were selected after considerations involving CONUS geographical locations, current operational missions, Air Force command functions, and availability of designated aircraft types using the selected equipments. In this study, the specified Air Force bases are coded from A through L, and the depots are coded X through Z.

The field survey team studied six different avionic equipments currently in operational use on ten different aircraft platforms at 12 designated AFBs. Since many of these avionic equipments are used on two or more different aircraft, a total of 40 different combinations (aircraft, equipment and AFBs) were observed by the survey team. A matrix indicating the selected equipments and their use on each of the designated aircraft at specified AFBs is presented in Table 2. The Operating Command relationships to designated aircraft (and aircraft types) are also presented in Table 2.

TABLE 2. SELECTED AIRCRAFT/EQUIPMENT/ AFB COMBINATIONS

AIRCRAFT (TYPE) AFB (OC*) \ EQUIPMENT DESIGNATOR	AN/ASN-90	AN/ARN-118	AN/APG-63 (RDP)	AN/ARC-164	AN/APX-101	AI /APN-167
B-52D (BOMBER) A (SAC)		X		X		
KC-135 (CARGO) A (SAC)		X		X		
A-10A (ATTACK) B (TAC)		X		X		
F-15A (FIGHTER) C (TAC)		X	X	X		
AC-130H (CARGO) D (TAC)	X	X		X		
A-7D (ATTACK) E (TAC)	X	X		X		
F-15A (FIGHTER) F (TAC)		X	X	X	X	
T-38 (TRAINER) F (ATC)		X		X		
F-15A (FIGHTER) G (TAC)			X		X	
F-111E (FIGHTER) H (TAC)		X		X		X
F-15A (FIGHTER) I (TAC)			X		X	
A-10A (ATTACK) I (TAC)		X		X		
F-5E (FIGHTER) I (TAC)						
FB-111A (BOMBER) J (SAC)						X
KC-135 (CARGO) J (SAC)		X		X		
T-38 (TRAINER) K (ATC)		X		X		
T-38 (TRAINER) L (ATC)		X		X		
F-5E (FIGHTER) L (ATC)				X		

*OPERATING COMMAND:

SAC = STRATEGIC AIR COMMAND
TAC = TACTICAL AIR COMMAND
ATC = AIR TRAINING COMMAND

2.3 SURVEY TEAM REPORTS

A field survey team was appointed to visit the Air Force base and depot maintenance facilities selected for this study. At each facility, the field survey team devoted an average of three days for observations, interviews, and investigations designed to determine the causes of unnecessary removals (URs) of avionic equipment. The field survey portion of this study covered the period of November 1979 through April 1980.

The field survey team recorded all pertinent observations made at the maintenance facilities. These included facility layout, practices, procedures and test equipment intended for repair activities of the selected equipment. A field survey report was completed by the field survey team for each selected aircraft/equipment/AFB combination.

A standard field survey report form comprised of 11 pages of specific questions and "continuation pages" was used by the field survey team (Appendix A). The questionnaire was formulated during the technical coordination meeting discussed in Paragraph 2.2. Forty report forms (comprising over 800 pages) were completed during this study. Excerpts from some of the observations reported by the field survey team are presented in Appendix B.

The information recorded in the field survey reports was obtained during observations and interviews with cognizant maintenance personnel at organizational, intermediate and depot levels. The interviews were candid, largely made possible by the assurance that anonymity would be preserved. The cooperation by all interviewed personnel contributed greatly to the successful completion of this study.

2.4 MAINTENANCE DATA BASE

The quantitative aspects of UR events studied herein are based on the use of available historical data pertaining to the field maintenance of the selected avionic equipment. The CY 1978 data (Appendix C) were obtained after review of documents, pamphlets and policy regulations that pertain to D056 and K051 data systems contained in AFLC Regulations. The CY 1979 data (Appendix F) were obtained by the field survey team from each of the twelve AFBs visited by the team. Completion of the data review and analysis effort, and the development of knowledge of the data base and its limitations, resulted in the refinement and validation of the data base.

The results of the field maintenance data collection and analysis task provided ordered data files containing the required factors for assessing the quantitative aspects of the URs of specified avionic equipment.

Maintenance data on avionic equipment in the CY 1978 CONUS operational inventories of four Air Force Operating Commands (ATC, MAC, TAC and SAC) on

24 selected aircraft and equipment combinations were collected, analyzed and summarized. These combinations include those observed by the field survey team. The CY 1979 maintenance data of avionic equipment relate to the ten aircraft platforms observed by the field survey team at twelve AFBs (Table 2).

2.5 DATA REVIEW AND ANALYSIS

The review and analysis of maintenance data records provided information relating to the number of removals of the specified equipment at the flightlines; and the number of those equipments which were repaired, adjusted or classified as URs in the base repair shops.

The data pertinent to the causes of URs are identified in Air Force maintenance data records as action taken (AT) Code P (on-aircraft removal), AT Code R (on-aircraft removal and replacement), and AT Code B ("Bench Checked - Serviceable" classification, after off-aircraft testing).

A job control number (JCN) is assigned for the initial base-maintenance work (and documentation) required to investigate any reported malfunction of equipment. The JCN is used to control and identify maintenance jobs, thus providing a means of "tying together" all on-equipment and off-equipment maintenance records involving a given maintenance event and work unit code (WUC) grouping. The JCN consists of seven characters: the first three characters represent the Julian day, and the last four characters are used to identify maintenance jobs. Thus, maintenance data can be analyzed based on matching the on-aircraft avionic equipment removal event record to the corresponding event's I-level shop maintenance action taken records.

However, some on-equipment removals cannot be matched to any subsequent I-level action taken, (i.e., no matching shop records bearing the same JCN can be found). Such "unmatched" removals may represent either a fault repair or a UR. The MDC system data analysis program normally classifies all such unmatched removals as a fault repair.

To correct this situation, an allocation model was formulated to estimate a more representative number of URs based on the known relationship of removals

found to be either faulty or serviceable at the I-level maintenance facility. The model is:

$$\text{TOTAL URs} = \text{MATCHED URs} + \text{UNMATCHED REMOVALS}\left(\frac{\text{MATCHED URs}}{\text{MATCHED REMOVALS} + \text{MATCHED URs}}\right)$$

where

TOTAL URs = Calculated number of URs

MATCHED URs = Number of "Bench Checked-Serviceables."

UNMATCHED REMOVALS = Number of unmatched removals (those due to missing shop records).

MATCHED REMOVALS = Number of removals found to be Type I How Malfunctioned (HOW MAL) codes.

This model is used during all UR analyses of 1978 MDC records with the postulate: unmatched removals have the same UR rate as the matched removals.

The output records of this study include all pertinent factors desired for each equipment, as identified by Work Unit Code (WUC) designations. Data records used to apportion the unmatched removals, discussed previously, are shown in Appendix C (refer to Key on page C-1). The WUC designations pertaining to this study are shown in Appendix D. AT designations are shown in Appendix E.

3.0 APPROACH

This section delineates the criteria, assumptions, and observations used as bases to achieve the objectives of this study.

3.1 CASUAL CONCEPTS

The primary objective of this study is to determine the causes of URs of avionic equipment. As used herein, the word "cause" applies to any circumstance, condition, event, or any combination thereof that brings about such UR. Since the concept of the term "cause" can be subject to a variety of interpretations, the following paragraphs present the "ground rules" used in this study, relating to the causes of URs.

Some causes of URs are deemed "simple" because they are obvious to most maintenance specialists. For example, operational management may require a deviation from a maintenance standard operating procedure to effect quick turnaround of priority sorties. In this case, the removal and replacement of suspect avionic equipment, with little or no organizational level (O-level) maintenance diagnostic testing, can be considered as "nonstandard troubleshooting" although performed as directed by management. This "simple cause" of a resulting UR is described as "Management Directive."

However, many causes of URs are multifaceted; involving the inherent testability of avionic equipment, the technician's ability to recognize a symptom and interpret the correct meaning, the adequacy of test equipment and procedures, the climatic and dynamic environments which are difficult to reproduce or simulate, the frustrating situation of intermittent malfunctions, etc.

An example of the intricate interrelationships involved in causes of URs is illustrated when a pilot, during post-flight debriefing, misinterprets symptoms and reports a "malfunction" of some avionic equipment. During the normal sequence of maintenance events, the pilot's report should be discovered as erroneous by investigating O-level maintenance personnel, who would then classify the reported malfunction of the on-aircraft suspect avionic equipment

as "Cannot Duplicate (CND)" (AT Code H, in MDC records) and order the equipment back into service. However, an issue arises when the suspect equipment described above is subsequently classified as a UR (AT Code B, in MDC records) by intermediate level (I-level) personnel.

In the latter situation, the O-level maintenance group has permitted a serviceable avionic equipment to be needlessly sent to the I-level test facility. In this case, the direct cause of the UR is attributable to the O-level maintenance activity. The cause of the UR can be ascertained by review of maintenance records and interviews with cognizant O-level personnel. Hence, the original misinterpretation of symptoms by the pilot (or perhaps some mistranslation by the debriefer) is deemed of secondary importance when compared with the O-level actions which result in a UR.

A typical maintenance flow diagram illustrating the generation of CNDs and URs is shown in Figure 2. In Figure 2, note the increasing number of physical actions and decision points as equipment proceeds through the maintenance process. Due to the complexity and subsequent time delays of the process, each physical action and decision point confounds the UR cause determination. For example, the confounding between O-level and depot level is so extreme that UR cause determination is virtually impossible.

3.2 OBSERVATIONS

An important factor in the completion of this study is the observations reported by the field survey team. Excerpts of reported field survey team observations at each AFB are presented in Appendix B.

Prior to arrival at each AFB, the field survey team coordinated anticipated tasks with the operational unit Deputy Commander for Maintenance (DCM). After arrival, the field survey team briefed the DCM, who thereafter arranged the necessary interviews with cognizant maintenance management personnel and authorized inspections of the support test facilities at O-level stations and I-level repair shops. Upon departure, the field survey team briefed the DCM as to the results of the interviews and inspections.

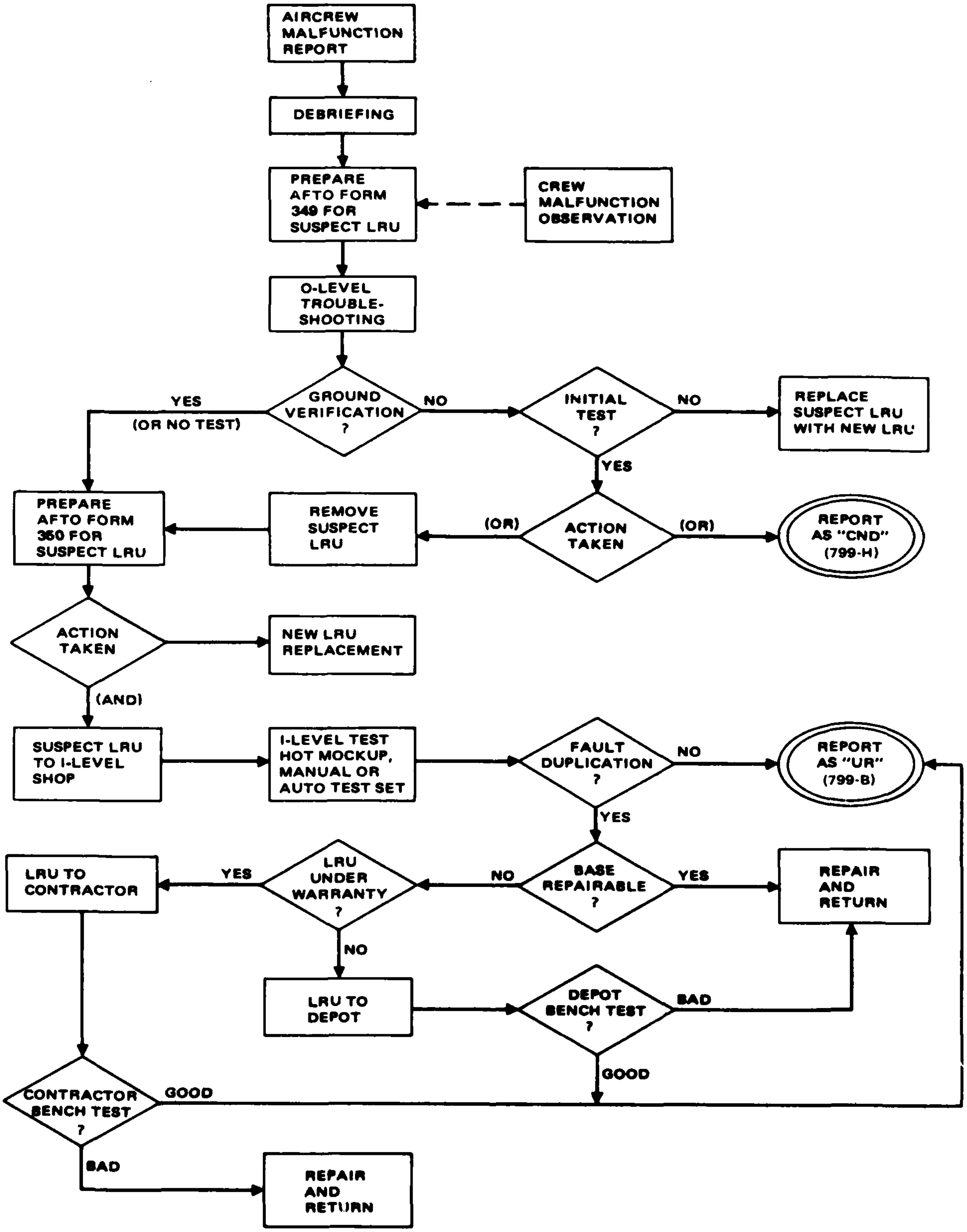

Figure 2. Typical maintenance flow diagram illustrating the generation of CNDs and URs.

The observations by the field survey team at AFBs and depots are recorded on field survey report forms (Appendix A) designed to cover the following areas:

- Equipment Identification
  - System nomenclature, Work Unit Code, aircraft platform, time in service, utilization, inaccessibility
  - System mission and function
- Maintenance Concepts
  - Organizational level maintenance
  - Intermediate level maintenance
  - Depot level maintenance
- Debriefing
  - Who, what, where, when, and how?
  - Documentation procedures
- Troubleshooting Methods
  - Techniques used at each level of maintenance
  - Technical orders
  - Training and skill levels
- Test Equipment
  - At each level of maintenance
  - Commonality
- Maintenance Data Reports
  - MDC system (AFB, aircraft, equipment)

Some observations regarding each of these areas are discussed in the following paragraphs.

3.2.1 Equipment Identification

The six avionic equipments discussed in this study are summarized in Table 3 as to function, BIT availability, user aircraft platforms, time in service, and system average flying hours per aircraft per month at each AFB. The equipments include a wide range of functional items of varying degrees of complexity. Table 3 is the result of interviews and investigations during AFB visits by the field survey team.

TABLE 3. AVIONIC EQUIPMENT DATA FROM FIELD SURVEY REPORTS

Equipment Designator	System/LRU - Function	Built In Test (BIT)	Aircraft Type	Equipment Time in Service (Years)	Sys. Average Flying Hours per Aircraft per Month	AFB
ASN-90	INERTIAL NAVIGATION SYSTEM - Provides acceleration, heading and attitude data to aircrew to permit the geographical positioning of the aircraft.	BIT	A-7D	10	25	E
		BIT	AC-130	10	39	D
ARN-118	TACAN - Provides bearing and range data on the horizontal situation indicator. TACAN is a polar coordinate navigation system used to determine the relative bearing and slant range distance to selected ground, shipboard or airborne TACAN stations.	BIT	A-7D	2	25	E
		BIT	A-10A	5	31	I
		BIT	A-10A	5	42	B
		BIT	F-15A	1.5	25	F
		BIT	F-15A	2	23	C
		BIT	F-111E	1	14	H
		BIT	B-52D	2	63	A
		BIT	AC-130	1	46	D
		BIT	KC-135	2	27	J
		BIT	KC-135	2	48	A
		BIT	T-38	1.5	25	F
		BIT	T-38	3	37	L
		BIT	T-38	3	33	K
APG-63	RADAR DATA PROCESSOR - Provides data to and receives data from the Control Computer. This Processor is the main controlling element of the APG-63 Radar Set.	BIT	F-15A	6	16	I
		BIT	F-15A	[illegible]	[illegible]	F
		BIT	F-15A	[illegible]	[illegible]	C
		BIT	F-15A	3.5	20	G
ARC-164	UHF COMMUNICATION SYSTEM - Provides air-to-air, air-to-ground or ground-to-ground radio communications in the 225 MHz to 399.975 MHz military band on 7000 separate channels.		F-111E	1	14	H
			A-7D	2.5	25	E
			A-10A	5	42	B
			A-10A	5	31	I
			F-5E	1	26	L
			F-5E	2	24	I
			F-15A	1.5	25	F
			F-15A	2	23	C
			B-52D	2	63	A
			AC-130	2.5	46	D
			KC-135	3	48	A
			KC-135	2.5	27	J
			T-38	1	25	F
			T-38	2	33	K
			T-38	4	37	L
APX-101	IDENTIFICATION - FRIEND OR FOE (IFF) SYSTEM - Provides security information: solid state unit decodes received interrogation/challenge and automatically actuates transmission of a coded reply signal.	BIT	F-15A	4	20	G
		BIT	F-15A	5	16	I
		BIT	F-15A	3	23	C
		BIT	F-15A	4	25	F
APN-167	RADAR ALTIMETER - Provides constant update of altitude data with input to the terrain following radar (TFR). Allows below radar surveillance attack of targets.	BIT	FB-111A	10	27	J
		BIT	F-111E	12	14	H

3.2.2 Inaccessibility

Most of the LRUs in the systems surveyed are easy to remove and replace. In fact, less time can be taken to remove and replace an item at the flightline than to set up test equipment and follow standard T.O. troubleshooting procedures. However, the inaccessibility of two of the LRUs of the ASN-90 Inertial Navigation System, the Inertial Measurement Unit (IMU) and the Power Supply Adapter (PSA), currently installed in the A-7D aircraft, directly affect the UR rate of the ASN-90 system. The PSA and the IMU are located in the left equipment bay, in the belly of the aircraft; and both LRUs are "safety wired" to their respective mountings.

The PSA has seven Cannon-type connectors which are virtually inaccessible and are difficult to remove. The IMU has four connectors that are equally difficult to remove. In order to remove a suspect IMU, the PSA must first be removed. Thereafter, the maintenance specialist may route both LRUs to the I-level shop for bench check. This procedure has no impact on the UR rate if the specialist writes up the good PSA as a removal to facilitate test of the suspect IMU (e.g., HOW MAL Code 800, in MDC reports) and returns the good LRU to the aircraft. However, if the maintenance specialist is in doubt as to which LRU is faulty, then the HOW MAL Code 800 (or other equivalent code number) is not used when both LRUs are sent to the I-level shop. Since both LRUs are rarely faulty at the same time, the UR rate for the good LRU is made higher.

3.2.3 Maintenance Concepts

The field survey team observed that some maintenance managers, at all levels, are not fully aware of the high cost inherent in the URs or the benefits that could result from the reduction in the number of URs. This condition exists despite the extensive USAF maintenance data record systems which have been established in all field organizations to identify repeat writeups and other problems in each aircraft and equipment. Some managers also believed that verification of equipment condition by I-level shop bench inspection and test is the best troubleshooting aid available. This observation was confirmed during interviews with the maintenance technicians.

3.2.3.1 Feedback

When feedback of UR information from I-level to O-level, or from depot-level to I-level, is not emphasized, the UR rate can be higher than otherwise. For example, when management makes one maintenance supervisor responsible for both O-level and I-level personnel (as observed at AFB "J") the causes and quantities of URs were reportedly reduced. This advantageous result at AFB "J" is deemed to have been achieved by effective feedback of UR information.

At AFB "L", an "inherent feedback" results because equipment utilization is high and turnaround time is short. In this case, all maintenance personnel are alert to repeat squawks on any LRU. Such inherent feedback makes repeat/recurring URs almost nonexistent.

3.2.3.2 POMO Concept

The Production Oriented Maintenance Organization (POMO), described in AF Regulation 66-5, is the maintenance concept employed by the Tactical Air Command (TAC). Briefly, the intent is to provide increased production with decreased manpower through the consolidation of maintenance skills. One of the principal contingency benefits of such a maintenance concept is rapid deployment of aircraft and logistics support assets to a remote "bare-base" location.

The Air Force requirement for mobility has an impact on the maintenance concepts of most of the Using Commands visited during this study. The I-level shop managers oppose "mobility demonstrations" for some of their automatic test stations because they are apprehensive about not being able to get their displaced equipments in an operable condition in the short time required. In essence, such mobility requirements can cause URs because an inoperative test station perpetuates wholesale cannibalization and unnecessary removals in order to keep the fighting force operationally ready and mission capable. A related study (Ref. 6) claims that the POMO concept can also lead to a lack of motivation in maintenance personnel if the reasons for POMO are unclear.

3.2.4 Debriefing

The field survey team observed that, in general, debriefing functions at AFBs are professionally conducted. Although procedures vary as to mission requirements, aircrew information (after flight) is obtained and used to effect necessary maintenance actions. However, the accuracy of debriefing writeups is directly proportional to the comprehension of the debriefers. The presence of an avionic specialist during debriefing was prescribed only at some of the AFBs. A related study (Ref. 7) reported that one AFB had UR problems which could be traced to inadequate debriefing (debriefers were unfamiliar with certain avionic equipment operation). The study (Ref. 7) suggested that known problems should be posted in the debrief room and referred to by debriefers and aircrews.

3.2.5 Troubleshooting Practices

Aircrews and flightline maintenance personnel are highly motivated by the need to keep aircraft flying, generate high operational readiness rates, and minimize turnaround times. These objectives sometimes preclude standard troubleshooting practices. For example, when a fault exists in one of two suspect LRUs, standard maintenance practice requires that each LRU be checked and only the faulty LRU shall be removed from the aircraft to the repair shop. On the other hand, the risk of lengthening turnaround time is minimized by simultaneously removing and replacing both suspect LRUs.

Some nonstandard troubleshooting and fault isolation practices were observed by the field survey team. These observations are discussed in the following paragraphs.

3.2.5.1 Organizational Level

Three unseemly O-level practices, observed by the field survey team, are as follows:

- "Shotgun" fault isolation — a process whereby all LRUs of an aircraft subsystem are removed for a bench check in the I-level shops. The LRUs that pass the test are reinstalled in the aircraft and those that fail are replaced (from supply stores or cannibalized from another aircraft).

- Trial and error troubleshooting — a process similar to shotgun fault isolation, but whereby the LRUs are removed, one at a time, and tested at the I-level shop until a faulty LRU is found.
- Substitution troubleshooting — a maintenance practice whereby suspected LRUs are substituted with known good LRUs until the malfunction is corrected.

Sometimes, one or another of these practices may be considered "legitimate," as when tactical requirements dictate that the timeliness of aircraft flights is of greater utility than the use of standard maintenance procedures to fault isolate reported malfunctions of avionic equipments. Nevertheless, the unnecessary removal rate can be expected to increase when standard troubleshooting procedures are circumvented to effect a quick return to flight status of an aircraft experiencing a suspected malfunction.

Further, the application of such expeditious troubleshooting practices for priority sorties can have a "lasting effect." That is, these practices can tend to become "accepted" maintenance operating procedures and may continue beyond the time of need.

3.2.5.2 Intermediate Level

At I-level maintenance, management surveillance is necessary to discourage unnecessary "adjustment" of avionic equipment. Such adjustment is sometimes employed to avoid a UR classification or "protect" new airmen who submit an excessive number of erroneous malfunction reports.

Although such activity only came to the attention of the survey team during personnel interviews, this activity was also reported in a related study (Ref. 6). That study suggests that "there may be pressure on the technicians to keep the CND rate low and a perfunctory adjustment or alignment may be reported even though no positive duplication of the malfunction was observed."

3.2.5.3 Depot Level

The three designated depot repair facilities sometimes receive avionic equipment from Air Force bases that have no apparent faults. However, depot data records do not afford means for determining the causes of such deliveries. Therefore, the discussion in this study relating to fault-free equipment found after depot-level maintenance testing is limited.

Troubleshooting at depot level is well regulated and standardized, as observed at the two depots visited by the field survey team. The third depot scheduled for visit was a contractor facility under a Reliability Improvement Warranty (RIW) contract to accomplish depot-level maintenance on certain avionic equipment. However, time constraints precluded the survey team visit to to the latter facility so pertinent information was obtained via telephone contacts.

At one depot, the field survey team found that some repair procedures require each LRU and SRU received from field sites be sequentially disassembled, cleaned, and reassembled prior to any testing. Such procedures may mask or eliminate an existing fault in equipment during the cleaning process. Thus, there may be no way to determine if no malfunction (UR) existed upon receipt at the depot. Further, there is the probability that a new malfunction can be induced in the equipment by the cleaning and handling process.

At another depot, a contractor repair facility for equipment under a RIW contract, only the contractor (manufacturer) is authorized to open and repair certain LRUs during the first four years of production deliveries. Therefore, the I-level shops only perform fault verification tests on suspect LRUs and ship seemingly faulty LRUs to the depot facility for repair. Under the terms of this RIW contract, whenever the number of "No Defect" returns exceeds 30 percent of the total returns, the contractor is reimbursed for the excess items processed. The contractor's maintenance data for 1979 indicate that the UR rate for the specific equipment related to this study was 34 percent.

3.2.5.4 Technical Orders

Technical Orders (T.O.s) are formal publications, frequently written by the original equipment manufacturer. They delineate (1) analytical troubleshooting procedures, and (2) tools and test equipment requirements for the maintenance specialist to perform his function at any of the three levels of maintenance. The use of technical orders is essential in the maintenance of avionic equipment, however, T.O.s are not always used properly. The reasons given to the field survey team for not using T.O.s during troubleshooting and repair of avionics equipment include the following.

- Troubleshooting procedures are too difficult to follow.
- Errors exist in the T.O.s.
- Too much time is needed to "follow" the T.O.s.
- Mission turnaround time does not permit use of T.O.s.
- The T.O. is difficult to use on the flightline, especially during bad weather (e.g., rain, snow).

Regardless of the reason, whenever shotgun troubleshooting or trial-and-error troubleshooting practices are used in lieu of following the T.O., a high UR rate can be expected. A related study (Ref. 7), involving one avionic system, reported that "T.O.s are seldom used for BIT checks or LRU removal and installation." Also, "in 17 of the 22 cases of invalid LRU removals that resulted in BCS (URs), the primary causal factor was found to be inadequate troubleshooting" (claimed as due to the failure to use specified T.O.s).

3.2.5.5 Procedures

Every repair location visited by the field survey team has a mission directive and written maintenance procedures. However, in practice, the two policies may not agree, creating a situation that allows maintenance activities to deviate from the specified T.O.s. The field survey team observed that some organizations, with a primary mission of pilot training, fly one aircraft three to four times in one day with a very short turnaround time. This leaves insufficient time for standard troubleshooting and repair of any reported malfunction between flights. In this case, troubleshooting by substitution

of LRUs can become the principal maintenance procedure, overriding written standard maintenance procedures.

The majority of such organizations have established "launch and recovery vehicles" that are stocked with pre-checked LRUs and are manned with maintenance specialists assigned to flightline duties. When an aircraft returns from a flight and the aircrew reports avionic malfunctions, the maintenance specialist replaces all suspect LRUs with good LRUs from the launch and recovery vehicle, until the malfunction is eliminated.

When a particular aircraft LRU malfunction cannot be duplicated by a maintenance specialist and he does not have sufficient spares aboard the launch and recovery vehicle, he will remove one or all the suspect LRUs and have them tested by the I-level shop for verification before reinstallation in the aircraft. This procedure takes about one and a half hours, which is usually faster than he could have drawn an LRU from Supply (assuming he knew which LRU was defective). In essence, the squadron's mission directive has dictated a nonstandard maintenance procedure (i.e., shotgun maintenance).

3.2.5.6 Training Programs

The training which airmen receive through technical training schools and from OJT (On-the-Job-Training) programs is deemed adequate. However, the field survey team observed that the instructions in the use of technical orders, test equipment, and standard troubleshooting procedures could receive greater emphasis during OJT. Without such emphasis, flightline personnel tend to employ troubleshooting by substitution, trial and error, or shotgun methods.

3.2.6 Test Equipment/BIT

Test equipment, to be an effective tool in O-level troubleshooting, must (1) isolate a system malfunction to one LRU, (2) save maintenance time, (3) be easy to transport, (4) be easy to set up, and (5) have the confidence of the flightline maintenance technician using the equipment. Certain test equipment observed during this study are large, heavy, outdated equipment that take much time to set up and perform the test function, and do not fault

isolate a system malfunction to the discrepant LRU(s). Therefore, such test equipment are not always used and maintenance technicians can become unfamiliar with their use and purpose.

Built-in-test (BIT) false alarms involve anomalies which largely rely on maintenance personnel for interpretations. This is an untenable condition, and leads to a lack of confidence in BIT by aircrews and ground crews. BIT problems are discussed in Paragraph 3.2.6.3.

3.2.6.1 Applicability

At several repair sites, bulky, outdated test equipment was available. However, due to its size (1-1/2 x 2 x 3 feet) and weight (40 pounds), this test equipment is seldom used by the flightline maintenance specialist. Since no other test equipment is available, O-level maintenance personnel forego on-aircraft testing, and instead remove a suspect LRU for bench check in the I-level repair shop. Without some O-level test, there is a high probability that certain suspect LRUs will be classified as UR in the I-level shop.

Testing in I-level shops varies between use of manual test stations, automatic test stations and hot mock-ups. Often, one type of test equipment is specified as applicable for an avionic equipment by a Technical Order, but I-level personnel tend to use any available test equipment that provides the quickest fault isolation of avionic equipment.

3.2.6.2 Commonality

At an I-level repair facility, there was evidence of a lack of commonality in the calibration of test equipment. The repair facility had two test stations which "test/fault isolate" the same LRU. However, a repaired LRU, when successfully tested on one test set, could not pass the same test on the other "identical" test set. The planned overhaul of the two test sets is expected to resolve the problem. During the time when there is such a discrepancy in calibration, it is possible that some LRUs will be erroneously classified as a UR or requiring adjustment.

Depot-level test equipment is considered adequate and well maintained. Nevertheless, there are instances of a lack of commonality between I-level

test equipment and depot-level test equipment. For example, an IMU LRU test set in Depot "Y" is different from the I-level test set because the depot test set compensates for earth movement as time elapses (i.e., the Schuler Effect), which produces slightly different LRU operating parameters than those measured on the I-level test set.

This situation has caused the affected AFB to institute a special "transportation integrity test" whereby all depot repaired LRUs are retested on I-level test sets. Experience has shown this procedure to be necessary, but extra maintenance effort is expended because of the lack of commonality between I-level test equipment and depot-level test equipment. At this AFB, the I-level maintenance personnel assert that if the special test is not performed, there will be increased potential for induced damage during maintenance, and an increase in the UR rate is likely.

3.2.6.3 Built-In-Test (BIT)

BIT has become prevalent in avionic systems today. Five of the six equipments observed by the survey team have BIT: ARN-118 TACAN, ASN-90 INS, APN-167 Radar Altimeter, APX-101 IFF and the APG-63 Radar Data Processor (RDP). A related study (Ref. 8) reported a false alarm rate for the RDP of 24 percent (11 unnecessary removals in 46 recorded removals). In another related study (Ref. 9), BIT was deemed to be a significant contributor to unnecessary removals. The latter study claimed that BIT can be too sensitive (with tolerances overly tight) to "one time fails" or "short duration faults."

BIT should provide the maintenance specialist with a rapid GO/NO-GO test for verification of aircrew reported discrepancies, as well as a fault isolation technique. The most significant benefit and principal reason for BIT popularity is that BIT largely eliminates the need for flightline test equipment. Also, BIT should be capable of identifying a failure in any one of the LRUs which comprise an avionic system. However, inadequate or inaccurate BIT fault-diagnostic tests used for identification of a defective LRU (as well as inconsistent BIT in-flight fault indications which cannot be duplicated on the ground) cause a lack of confidence by maintenance personnel in the system BIT (Ref. 10). Thus, the maintenance specialist will often resort to "shotgun

maintenance" (which can cause unnecessary removals) when this lack of confidence develops. The same lack of confidence tends to make many pilots ignore BIT fault indications unless they have other corroborating evidence of a problem in the functional subsystem.

An analysis to pinpoint BIT as a specific cause of URs would require detailed documentation of BIT indications which are interpreted by an operator as symptoms of equipment malfunctions. In addition, such documentation must be matched with subsequent actions taken at all levels of maintenance. Thus, BIT indications which result in URs can be analyzed and corrective action can result.

A related study (Ref. 7) claims that many maintenance actions are not performed in accordance with approved procedures, and clearly involve the misuse of BIT. The primary cause of BIT related URs was found to be inadequate troubleshooting, rather than BIT anomalies. Further, the study claimed that "known BIT problems are usually corrected by software changes and should not result in wasted maintenance time in the interim." These claims corroborate observations and interviews by the SCURAE survey team, which indicated that some BIT problems resulting in URs could be considered as a nonstandard troubleshooting problem rather than a test equipment problem.

3.2.7 Maintenance Data Input

Input to the USAF Maintenance Data Collection (MDC) system relating to avionic equipment malfunctions is accomplished at AFBs in accordance with 00-20-2-series Technical Orders.

Data entries are transferred from base maintenance forms into the base computer files. Excerpts of Air Force documents pertaining to MDC system forms and data elements (codes) are shown in Appendix E. The maintenance data and analysis methods are discussed in Paragraph 2.4.

The field survey team observed that, typically, the malfunctions of avionic equipment are initially documented by the aircrew on AFTO Form 781 (Aerospace Vehicle Flight Data Document), which is given to the debriefer after aircraft (A/C) landing. The debriefer, thereafter, completes an AFTO Form 349 for each reported malfunction and sends copies to Job Control and

cognizant O-level maintenance personnel. If O-level personnel discover that the malfunction involves an equipment requiring I-level shop repair, an AFTO Form 350 is completed and routed with the suspect equipment to the I-level shop.

In the I-level shop, an AFTO Form 349 is originated by transcribing the O-level AFTO Form 350 information, including the actions taken at I-level. Copies of AFTO Form 349 are forwarded to Job Control, Planning and Scheduling, and Analysis functions. AFTO Form 95 (Significant Historical Data) is used as a history record, filed by A/C tail number and/or WUC, for about one year.

At certain AFBs, specific forms are prescribed. For example, TAC debriefing personnel use TAC Form 93 (Sortie Maintenance Debriefing). During SAC debriefing, SAC Form 77 (Checklist/Checksheet), SAC Form 126 (Mission Record - APG) and SAC Form 126a (Mission Record - Avionics) are used to record each reported malfunction. Repeat/recurring failure identification is utilized at all commands; e.g., TAC Form 122 (Abort/Incident Investigation Record) is used by TAC maintenance personnel.

4.0 ANALYSES

The analyses herein are based on the (1) observations and interviews made by the field survey team during the period of November 1979 through April 1980, (2) maintenance data base derived from field records, and (3) review of related literature. The results of the analyses constitute the basis of subsequent conclusions and recommendations regarding the causes and extent of the unnecessary removals (URs) of avionic equipment.

4.1 DETERMINATION OF THE CAUSES OF UNNECESSARY REMOVALS

The field survey team visited twelve AFBs to determine the causes of URs. When the survey was completed, a study team analyzed the Field Survey Reports (excerpts are in Appendix B) and categorized the causes. The study team found nine basic causes, defined as follows:

1. Ineffective BIT problems relate to built-in-test designs which provide incomplete or ambiguous information to aircrew and ground crew operators. Such incomplete information is the reason that operators must "interpret" BIT indications. Thus, there are instances when BIT indications are misinterpreted and an avionic equipment is erroneously reported as malfunctioning. Such "malfunctions" are termed false alarms and result in a CND or UR classification. These false alarms may either indicate a malfunction in a serviceable equipment when there is actually no malfunction in the system, or may not indicate a fault when one exists in the equipment.

   Recurring BIT false alarms cause a lack of confidence in the performance of BIT, which results in aircrews and ground crews ignoring BIT indications. In this case, affected personnel use their own logic in determining if an avionic equipment is malfunctioning (Refs. 6, 7, 8, 9 and 10). The problem of URs arises when the logic used by maintenance personnel cannot locate a malfunctioning equipment and shotgun or trial-and-error maintenance practices, or use of the I-level test facility is employed. BIT false alarm problems, reported in related studies, are discussed in Paragraphs 4.3.5 and 4.3.6.

2. Ineffective T.O.s usually result in bypassing troubleshooting procedure steps, as well as nonuse of the T.O. Regardless of the type of deviation, this practice can result in fault-free LRUs being removed from aircraft.

Avionic equipment is restored to operation through replacement of suspect LRUs rather than by troubleshooting a malfunction in accordance with the T.O. (Ref. 6). T.O.s that require a long time to find the failed equipment tend to cause technicians to take short cuts, especially during inclement weather, as discussed in Paragraph 3.2.5.4.

3. Test Equipment Differences between different levels of maintenance were noted by the survey team on relatively "new" equipment. A lack of commonality in the calibration of test equipment was also discerned by the field survey team at one repair facility. At AFB "E", certain LRUs received from the repair depot are retested because of the lack of commonality between I-level test equipment and depot-level test equipment. Cognizant personnel at this AFB assert that if such retesting is not performed, an increase in the UR rate is likely. These problems are discussed in Paragraph 3.2.6.2.

4. Ineffective or Missing Test Equipment includes heavy or bulky test equipment. In most cases ineffective, heavy or unwieldy test equipment is the same as missing test equipment since it is not used. In this case, nonstandard troubleshooting is employed.

5. Inadequate Skill of maintenance technicians in the use of T.O.s, test equipment and troubleshooting procedures is a phrase which summarizes the technicians' inability to completely cope with the relatively high technology of electronic equipment. This cause of URs is due to the technician not remembering every detail of his past training; be it formal, OJT, technical readings or just familiarization with equipment and/or available diagnostic methods.

   In two of the three cases relating to inadequate skill, cited in Appendix B, unfamiliarity with equipment is reported. This phenomenon is also termed "learning curve" in industry, and as a result an increase in URs can be expected. Conversely, a decrease in URs can be expected as maintenance personnel gain experience.

6. Ineffective Supervision/Support involves control of the work habits of maintenance technicians. Although a lack of such support may be a result of the current short supply of middle management personnel, special attention of supervision is often necessary to maintain control of the UR rate.

   Lack of adequate troubleshooting, incorrect use of test equipment, improper or inadequate documentation, and lack of historical tracking of aircraft and LRUs for intermittent problems all tend to point to the lack of effective direct supervision (Ref. 7).

The field survey team's review of AFB data files indicated instances of reporting deficiencies, such as incorrect code entries for JCN, AT, WUC, etc. This is illustrated by the fact that a special methodology was required in this study to account for "unmatched removals" (JCNs for O-level removals do not match JCNs for I-level actions taken). Active supervision support can alleviate such situations.

7. Management Directives relate to bypassing the normal standard troubleshooting procedures to obtain quick-response turnaround times for priority sorties. There are times when turnaround time is most important and any supporting action is justified. However, this type of nonstandard action should be under regular surveillance by auditing personnel.

   Also, when new management directives (e.g., concepts such as POMO) are issued, the effect on personnel morale must be considered. Such consideration is deemed essential in reducing undesirable work habits that impact the UR rate.

   There are also situations when deviation from standard practice could result in more efficient troubleshooting methods. For example, in an aircraft with dual systems, black-box swapping may be a more efficient method of troubleshooting.

8. Inadequate Feedback of pertinent information between maintenance organizations reduces the effectiveness of the learning process. When virtually no communication exists between O-level and I-level organizations, flightline technicians are not aware of I-level disposition of LRUs removed from the aircraft. Feedback takes the form of interorganizational communications or the delegation of one supervisor to be responsible for more than one tier of maintenance activity. When equipment utilization is high and turnaround time is short, all maintenance personnel are alert to repeat squawks on any LRU. Such "inherent feedback" among these personnel makes repeat/recurring URs almost nonexistent at AFB "L."

9. Inaccessibility cannot be overlooked. The inaccessibility problem is a cause of URs at AFB "E", involving the ASN-90 in the A-7D aircraft.

   When LRUs are not readily accessible due to some restricted location, the removal of a suspect LRU may require the removal of one or more adjacent LRUs. Also, the difficulty in reaching a suspect LRU may preclude an on-equipment check, and the suspect LRU is removed and sent to the I-level shop for bench check. These problems are discussed in Paragraph 3.2.2.

4.1.1 Judgement Ground Rules

The study team studied the field survey team's Field Reports for documented phrases which provide reasons to judge the cause or causes of URs at the visited AFBs. The pertinent phrases, relating to all interviews, are underlined on the Field Survey Reports Excerpts in Appendix B. To make the UR judgements, the study team used the definitions of the causes of URs discussed in Paragraph 4.1, and adopted the following ground rules:

1. BIT is judged ineffective when BIT is known to be available (and may be used) but URs result after maintenance personnel bypass BIT and fault isolation by such nonstandard troubleshooting practices as "LRU substitution" (remove and replace LRUs until malfunction is corrected).
2. If no reason is indicated for deviation from T.O.s, such as LRU swapping, the cause is judged Ineffective Supervision (i.e., supervision permitted these deviations to happen).
3. If quick turnaround is the reason (or when a "maintenance truck" is used) for suspect LRU replacement (without using the T.O.s), the cause is judged Management Directive.
4. If dual installations exist in the aircraft (e.g., F-15A/ARC-164) and troubleshooting is performed by swapping boxes, the cause is judged Management Directive.
5. For those reports which indicate more than one cause, each cause is given equal weight as to the number of URs or judgements.
6. When Field Survey Reports make direct reference to the cause, that cause is used without further judgement. Examples of such direct references are:
   - "The test equipment is too heavy or bulky."
   - "The URs are probably due to insufficient training or new equipment" (this situation is herein entitled "Inadequate Skill").
   - "The company representative indicated that the I-level test set needed software changes."
7. If applicable phrases could not be discerned, no judgement was made (e.g., APN-167/F-111E, page B-27).

Each Field Survey Report Excerpt (Appendix B) is identified with the UR cause category(s) assigned for the equipment-aircraft-base combination reported. This identification is shown in the upper right corner and is in the form of the number(s) assigned to the cause(s) in Section 4.1.

The fold-out page in Appendix G should be open to view during the reading of the following paragraphs.

The study team's analysis of the Field Survey Reports is summarized in the table labeled Appendix G. Six equipments were studied and are listed in the first column. The next column "AFB" is the coded identification for each of the twelve Air Force bases visited by the field survey team. At each AFB, one or more of the six equipments are used on one or more of ten different aircraft platforms. For example, the ARN-118 equipment is used on eight different aircraft platforms at eleven different AFBs. The pertinent aircraft is shown in column "A/C".

The column "Page No." refers to the page number designations of the Field Survey Reports in Appendix B. The column "Total URs" represents the number of URs recorded for each noted combination (equipment/aircraft/AFB) in CY 1979 maintenance data records (Appendix F).

The study team assigned one or more of the nine causes of URs (listed in Section 4.1) to the totality of URs for each combination. The column "Total Causes" shows the number of causes assigned to each combination. The number assigned to represent each cause of URs and the cause designation are shown at the head of the nine main data entry columns.

Each of the cause columns has two subheadings: "J" and "Alloc URs". Each item listed under J (Judgment) is the reciprocal of the total causes assigned to each pertinent combination. This is the same as weighting each cause equally for a combination. Each item listed under Alloc URs represents an allocation of the total URs multiplied by the weighting factor J.

The last two columns represent the total judgments (J) and URs for each equipment combination. The grand total of judgments is shown to be 39, and the grand total of URs is 1,008. Near the foot of the table, totals for each cause column are shown, and the percentage of each total with respect to the corresponding grand total are shown.

The following examples illustrate the meaning of the rows entitled "Totals By Cause Category" and "Percentage (Of Grand Total)": The 12-1/3 judgments, which are applicable to Cause Number 1, constitute 32 percent

of the 39 judgements (grand total). In calculating the judgement values, when more than one cause is judged to be pertinent, each is weighted equally and each equipment-aircraft-AFB combination is given a value of 1. Since there are 39 combinations that could be classified as to cause, the total judgements equal 39.

Further, the 223-1/6 URs allocated to Cause Number 1 constitute 22 percent of the 1,008 URs (grand total). In calculating the number of URs, when more than one cause is assigned to an equipment-aircraft-AFB combination, the number of URs is divided equally between the causes.

Since the ASN-90 equipment is deemed to have a disproportionate number of URs, the two rows at the foot of the table are included to show corresponding results if the ASN-90 equipment data are censored.

4.1.2 UR Cause Ranking

The UR causes are ranked by the number of URs attributed to the pertinent equipment-aircraft-AFB combination. The number of URs used in the ranking is based on the CY 1979 maintenance data records obtained from each base (Appendix F) by the field survey team. The reason for using the CY 1979 maintenance data (rather than CY 1978 data) is that several changes occurred to the equipment inventory from 1978 to 1979. For example, the CY 1978 maintenance data records (Appendix C) do not include data from the ARN-118 and the ARC-164 in the F-15A. This would reduce the data by four equipment-aircraft-AFB combinations. Also, from 1978 to the time of the survey, many administrative and personnel changes could have occurred at the AFBs. Thus, the CY 1978 MDC records in the Hughes computer files are not used for UR cause ranking.

The table in Appendix G (derived from data in Appendix F) indicates that:

1. The bulk of the ARC-164 URs are management oriented.
2. The ASN-90 is the only equipment studied that has inaccessibility problems.
3. The URs of the other four equipments are equipment oriented.

Table 4 shows the ranking of the causes using the following methods.

TABLE 4. RANKING OF THE CAUSES OF URs

Cause	URs	URs Less ASN-90
	Rank (Percent)	Rank (Percent)
Ineffective BIT	1 (22)	1 (35)
Ineffective or Missing Test Equipment	2 (18)	5 (9)
Ineffective Supervision/Support	3 (16)	2 (25)
Ineffective T.O.	4 (13)	7 (1)
Inaccessibility	5 (12)	9 (0)
Management Directive	6 (7)	3 (11)
Test Equipment Differences	7 (7)	4 (10)
Inadequate Skill	8 (5)	6 (7)
Inadequate Feedback	9 (1)	8 (1)

1. The column entitled "URs" is the ranking based on the number of URs attributed to a cause. The numbers in parentheses are the percentages of the URs assigned to the cause. If more than one cause is assigned to an equipment-aircraft-AFB combination, the number of URs is divided equally between the causes.
2. The second column is the ranking of the causes similar to the column entitled "URs" except that ASN-90 data are deleted. The ASN-90 comprises one-third of the total URs and this is for one equipment-aircraft-AFB combination. It is felt that a meaningful ranking of the causes will result if the ASN-90 data are deleted.

The column entitled "URs" differs markedly from the "URs Less ASN-90" column. In the latter column, Test Equipment Differences are ranked relatively high because of the large number of URs for the F-15A/RDP combinations. The three causes ranked in the upper five of the column listings and common to both are:

1. Ineffective BIT
2. Ineffective or Missing Test Equipment
3. Ineffective Supervision/Support.

These three causes are candidates for corrective action by reason of numbers of equipments and URs.

The following is an analysis of the other six causes of URs:

- Management Directive ranks third in the column entitled "URs Less ASN-90." Thus, this cause of URs could be considered as another candidate (along with the three causes noted above) for corrective action by reason of numbers of equipments and URs.

- Ineffective T.O.s could be classified as a single equipment problem (ASN-90), along with Inaccessibility (ASN-90) and Test Equipment Differences (APG-63/RDP). How many of the causes classified as equipment oriented are indicative of avionic equipments not surveyed is unknown. In any event, blanket correction action may not be appropriate.

  The Field Survey Report excerpt on page B-4 (Appendix B) shows that Ineffective T.O.s were found at I-level. However, since this cause (related to an ARC-164 equipment problem at I-level) was only mentioned one time, little significance is given to this report item.

- Inadequate Skill, which has entries related to three equipments, may be transitory in nature, since it may be due to the equipment being new at an AFB or unfamiliar to the flightline crew when the survey was being made. Field Survey Reports B-4 and B-19 indicate this condition. Therefore, corrective action may be automatic as the crew becomes familiar with the equipment (learning curve effect).

- Inadequate Feedback could be included as an element of Ineffective Supervision, but the study team considered this an important cause in its own right. To include Inadequate Feedback in another cause would not give it the emphasis it deserved. Although it was referenced in only one entry, it cannot be considered an equipment oriented cause and corrective action must be general.

4.2 UNNECESSARY REMOVAL RATES

The field survey team observed that the UR rates of the selected avionic equipment had considerable variability in comparisons of use on different aircraft platforms, and use in similar aircraft platforms at different AFBs. These observations were largely substantiated during engineering analyses designed to determine the quantitative aspects of URs in avionic equipment.

In this study, the word "equipment" refers to a line replaceable unit (LRU) as well as two or more LRUs operating together in an avionic subsystem. For example, the Radar Data Processor (RDP) is an LRU in the APG-63 Radar Set. The RDP is one of the six selected equipments in this study, and is represented by Work Unit Code (WUC) 74FQO.

On the other hand, the ARN-118 (TACAN) equipment in this study is represented by WUC 71ZZZ (used during analysis involving CY 1978 MDC records) which is comprised of four LRUs. These LRUs are the Receiver/Transmitter (WUC 71ZAO), Digital-to-Analog Converter (WUC 71ZBO), Mount (WUC 71ZCO), and Control (WUC 71ZDO). WUCs ending with the letters ZZ are Hughes designations of equipment which include related, specific LRUs; which are analyzed herein. The equipments (and pertinent WUCs) in this study are listed in Appendix D.

4.2.1 Uniqueness and Variability of Equipment

The field survey team found that each of the six selected equipments are unique and varied in field experience. The field experience involves mission environments on different aircraft platforms, as well as effects of different maintenance policies at the AFBs. These observations are largely substantiated by analysis of maintenance data records and related studies.

The uniqueness and variability of the six specified avionic equipments are shown in the following listing of ranges of UR rates, which are ascertained from CY 1979 maintenance data records (Appendix F):

Equipment Designation	Number of AFBs	Range of UR Rates (Percent)	Number of A/C Platform Types
ARN-118	11	80 - 0	8
APG-63 (RDP)	4	76 - 37	1
ASN-90	2	66 - 2	2
APX-101	4	46 - 10	1
ARC-164	11	39 - 0	9
APN-167	2	10 - 0	2

Another viewpoint is gained by listing the ranges of UR rates applicable to specific aircraft platform types, as follows. In general, attack, fighter, and trainer aircraft experience a higher UR rate compared with bomber and cargo aircraft. However, in the case of ARC-164 equipment, the differences in UR rates are less noticeable.

Equipment Designation	AFB(s)	Aircraft Platform	Aircraft Designation	Range of UR Rates (Percent)
ARN-118	E	Attack	A-7D	49
	B, I	Attack	A-10A	73 - 59
	A	Bomber	B-52D	40
	D	Cargo	AC-130	0
	A, J	Cargo	KC-135	15 - 0
	C, F	Fighter	F-15A	80 - 21
	H*	Fighter	F-111E	(No data avail.)
	F, K, L	Trainer	T-38	>80* - 22
APG-63 (RDP)	C, F, G, I	Fighter	F-15A	76 - 37
ASN-90	E	Attack	A-7D	66
	D	Cargo	AC-130	2
APX-101	C, F, G, I	Fighter	F-15A	46 - 10
ARC-164	E	Attack	A-7D	18
	B, I	Attack	A-10A	30 - 11
	A	Bomber	B-52D	18
	D	Cargo	AC-130	36
	A, J	Cargo	KC-135	6 - 5
	I, L	Fighter	F-5E	24 - 0
	C, F	Fighter	F-15A	36 - 8
	H*	Fighter	F-111E	(No data avail.)
	F, K, L	Trainer	T-38	39 - 26
APN-167	J	Bomber	FB-111A	10
	H*	Fighter	F-111E	(No data avail.)

*No data available or censored.

Taking another point of view relating to the Appendix F data: 65 percent of the causes (top two) of URs pertinent to the ARM-118 equipment involve Ineffective BIT and Ineffective or Missing Test Equipment (machine factors). This situation can be compared with the 86 percent of the causes (top two) of URs pertinent to the ARC-164 equipment which involve Ineffective Supervision/Support and Management Directives (human factors). The varieties of causes of URs found in the ARN-118 and ARC-164 equipment may be found in the other equipment.

4.2.2 Selected Aircraft, Equipment and AFB Combinations

In order to gain additional insight regarding the frequency of occurrences of URs, an analysis of CY 1978 MDC records (Appendix C) relating to an AF inventory of the specified six equipments is summarized in Table 5. These equipments are installed aboard 13 different aircraft platforms (including nine aircraft observed by the field survey team) at CONUS AFBs. Since some equipments are used on two or more aircraft types, a total of 24 equipment/aircraft "combinations" are involved in this analysis. The average UR rate in this inventory is 32.7 percent (i.e., 2965/9071 x 100), given in Table 5. The combined UR rates of both bomber and fighter type aircraft are shown near the foot of Table 5. As used in this analysis, the term "bomber" includes bomber and cargo aircraft, and the term "fighter" includes fighter, attack and trainer aircraft. Also, the combined UR rates of each specified equipment (in all aircraft) are shown at the foot of Table 5.

Since frequency distribution figures are a useful first step in statistical analysis, Table 5 data are presented as histogram frequency distributions, as follows. The five-cell format of the histograms identify equipment/aircraft combinations which experience high UR rates, and focus on those combinations whose UR values are greater than the median of the combinations in each histogram. The greatest saving in time, manpower and costs may be realized by a reduction in the UR rate of these high value combinations.

TABLE 5. INVENTORY OF SELECTED AIRCRAFT/EQUIPMENT COMBINATIONS***

Aircraft	Equipment	Specified LRUs	WUC	Equip Inv	Equipment Flight Hours	Matched Removals	Unmatched Removals	Matched URs	Total Removals	Total URs	Percent URs	URs/1000 Flt Hours	URs/Million Part Hours In Flight
A-7D	ARC-164	All	63CZZ	207	59,832	121	78	30	229	46	20.1	0.77	0.47
A-7D	ARN-118	All	71ZZZ	262	75,052	76	91	54	221	92	41.6	1.23	0.43
A-7D	ASN-90	All	73FZZ	354	100,881	667	355	463	1485	609	41.0	6.04	1.63
A-10A	ARC-164	All	63AZZ	102	44,537	67	33	18	118	25	21.2	0.56	0.34
A-10A	APX-101	R/T	65AAO	102	44,537	55	18	14	87	18	20.7	0.40	0.21
A-10A	ARN-118	All	71ZZZ	102	44,537	28	31	22	81	36	44.4	0.81	0.28
B-52*	ARC-164	All	63EZZ	288	112,218	110	104	17	231	31	13.4	0.28	0.17
B-52*	ARN-118	All	71ZZZ	336	129,227	93	111	128	332	192	57.8	1.49	0.52
C-130*	ARC-164	All	63AZZ	1009	539,298	295	288	63	646	114	17.6	0.21	0.13
C-130*	ARN-118	All	71ZZZ	477	254,015	101	113	72	286	119	41.6	0.47	0.16
C-141	ARN-118	All	71ZZZ	308	321,104	114	151	31	296	63	21.3	0.20	0.07
F-15A	APX-101	R/T	65AAO	278	68,514	185	56	57	298	70	23.5	1.02	0.52
F-15A	APG-63	RDP(081)	74FQO	278	68,514	285	177	265	727	350	48.1	5.11	0.96
F-1C1	ARC-164	All	632ZZ	228	47,594	87	38	30	155	40	25.8	0.84	0.51
F-111*	ARN-118	All	71ZZZ	251	48,017	66	39	93	198	116	58.6	2.42	0.84
F-111**	APN-167	All	73CZZ	338	63,258	671	147	213	1031	248	24.1	3.92	2.31
FB-111A	APN-167	All	73CZZ	66	16,469	217	41	28	286	33	11.5	2.00	1.18
KC-135A	ARN-118	All	63RZZ	1236	430,482	316	265	124	705	199	28.2	0.46	0.28
KC-135A	ARN-118	All	71ZZZ	150	51,351	50	71	38	159	69	43.4	1.34	0.47
T-37	ARC-164	All	633ZZ	685	251,502	292	165	105	562	149	26.5	0.59	0.36
T-38	ARC-164	All	63BZZ	497	173,198	128	97	51	276	79	28.6	0.46	0.28
T-38	ARN-118	All	71ZZZ	691	241,747	166	75	121	362	153	42.3	0.63	0.22
T-39	ARC-164	All	632ZZ	125	105,188	78	86	29	193	52	26.9	0.49	0.30
T-39	ARN-118	All	71ZZZ	99	82,851	22	55	30	107	62	57.9	0.75	0.26
Total	Equip	Fleet		8469	3,373,923	4290	2685	2096	9071	2965	32.7	0.88	0.53
Total	Bomber	Fleet		3870	1,854,164	1296	1144	501	2941	820	27.9	0.44	0.30
Total	Fighter	Fleet		4599	1,519,759	2994	1541	1595	6130	2145	35.0	1.41	0.76
Total	ASN-90	Fleet	73FZZ	354	100,881	667	355	463	1485	609	41.0	6.04	1.63
Total	ARN-118	Fleet	71ZZZ	2676	1,247,901	716	737	589	2042	902	44.2	0.72	0.25
Total	APG-63	Fleet	74FQO	278	68,514	285	177	265	727	350	48.1	5.11	0.96
Total	APX-101	Fleet	65AAO	380	113,051	240	74	71	385	88	22.9	0.78	0.40
Total	ARC-164	Fleet	63ZZZ	4377	1,763,849	1494	1154	467	3115	735	23.6	0.42	0.25
Total	APN-167	Fleet	73CZZ	404	79,727	888	188	241	1317	281	21.3	3.52	2.07

*Data represent composite inventory of aircraft equipment:

B-52/ARC-164 includes B-52D, G&H
B-52/ARN-118 includes B-52D, G&H
C-130/ARC-164 includes C-130A, B&E
C-130/ARN-118 includes C-130A, B&E
F-111/ARN-118 includes F-111A, D&E

**Data represent composite inventory of aircraft equipment:

F-111/APN-167 includes F-111A, D, E&F

***Source: 1978 MDC Records.

In the histograms, only the combinations falling in the cells to the right of the median line cell are identified. Thus, the remaining combinations listed in Table 5 are included in the remaining class intervals and the specific designations are omitted for the sake of brevity.

The histogram of the number of URs is shown in Figure 3. This histogram is positively skewed with only 7 equipment/aircraft combinations outside of the first (left hand) cell. All of the equipments are included in these 7 combinations except the APX-101 (in any combination) which is below the median (74.5).

The histogram in Figure 4 illustrates the percent of URs of the total number of removals. This histogram has only one equipment/aircraft combination in the first cell, but the other four cells are reasonably flat. From another viewpoint, this histogram may be considered bell shaped, with the median (27.6) close to the center of the histogram. The ten equipment/aircraft combinations, with the highest percentage of URs, include the ASN-90/A-7D and the APG-63 (RDP)/F-15A. The other eight are all ARN-118 equipment/aircraft combinations. Only one ARN-118 combination (ARN-118/C-141) has a percent URs which is less than the median.

A related study (Ref. 5) shows that one reason that the ARN-118 combinations do not dominate the upper position of other histograms is that the ARN-118 is relatively more reliable and has fewer removals. Hence, although the percent URs are high, the total number of URs are low. The ARN-118 is an RIW equipment maintained by contractor repair facilities, and may often appear above the median due to the probably more conservative (RIW) approach to malfunction reports.

The histogram in Figure 5 addresses the issue of URs as a function of usage (flight hours). Usage, in terms of URs per 1000 flight hours, assumes that all equipments possess the same characteristics, except the number of "on-hours." Thus, this histogram indicates a comparison of rates of removal with respect to time. The median is at 0.76 UR per 1000 flight hours. If the quantity of URs were a function of usage, then the positive skewness of Figure 5 would be diminished compared to the Figure 3 histogram (UR rate). However, since both histograms possess the same order of skewness, the conclusion is that the URs are not a function of usage.

The histogram in Figure 6 addresses the issue of URs as a function of equipment complexity. To reflect the quantity of URs per million part hours during flight, the equipment part count must be multipled by the flight hours listed in Table 5. The quantity of electronic parts in each of the specified equipments is as follows:

Equipment Designation	Electronic Parts
APG-63 (RDP)	5,320
ASN-90	3,700
ARN-118	2,870
APX-101	1,951
APN-167	1,700
ARC-164	1,640

Hence, the URs per million part hours during flight is calculated by dividing the total URs by the product of the parts count and the flight hours (discussed above). The resultant is multiplied by a factor of 10^6 to express "removals per million part hours." The median is at 0.35 UR per million part hours during flight (Figure 6).

The positive skewness of the histogram in Figure 6 is almost the same as the histograms in Figures 3 and 5. Therefore, the conclusion (based on similar considerations as those relating to Figure 5) is that the URs are not a function of equipment complexity.

An overview of the histograms in Figures 3 through 6 indicates that certain equipment/aircraft platform combinations regularly appear above the majority. These combinations are considered the "heavy contributors" to the UR rate in the inventory. In the histogram of the percentage of URs (Figure 4), the ARN-118 equipment dominates as the heavy contributor. However, in the remaining histograms (Figures 3, 5 and 6), there is a commonality of equipment/aircraft combinations that consistently appear in the high value combinations. These combinations are:

ASN-90/A-7D
APG-63 (RDP)/F-15A
APN-167/F-111
ARN-118/B-52

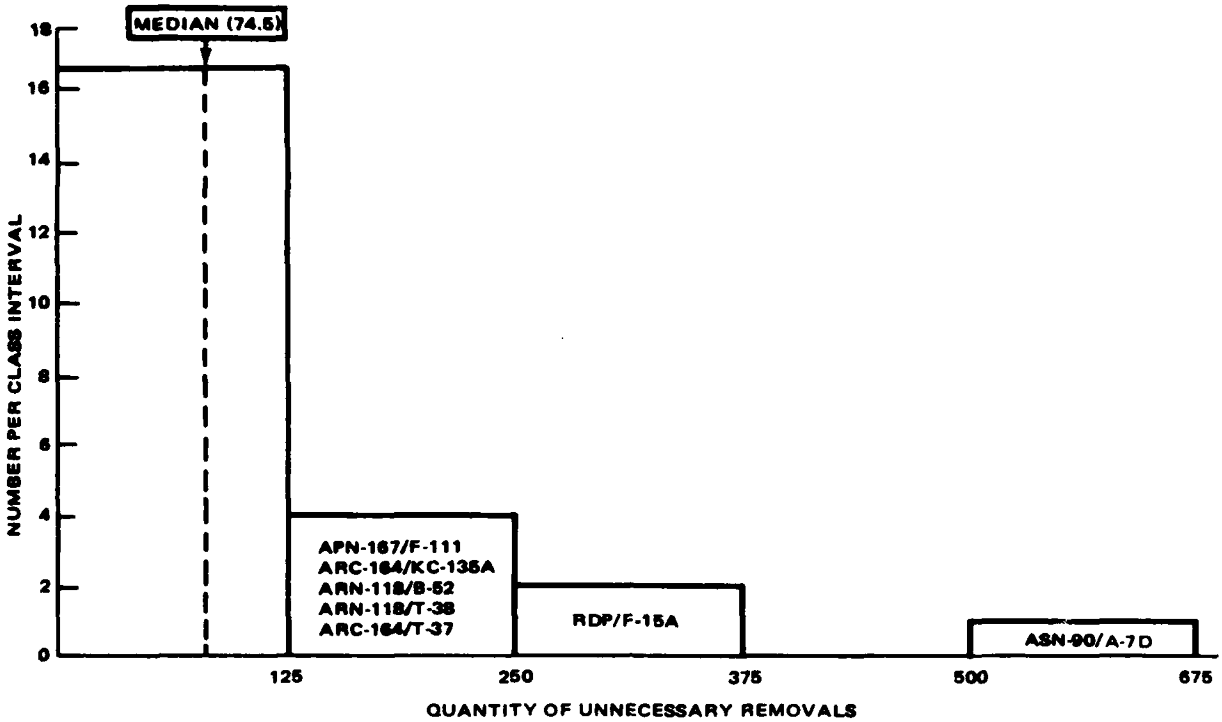

Figure 3. Histogram of the quantity of unnecessary removals.

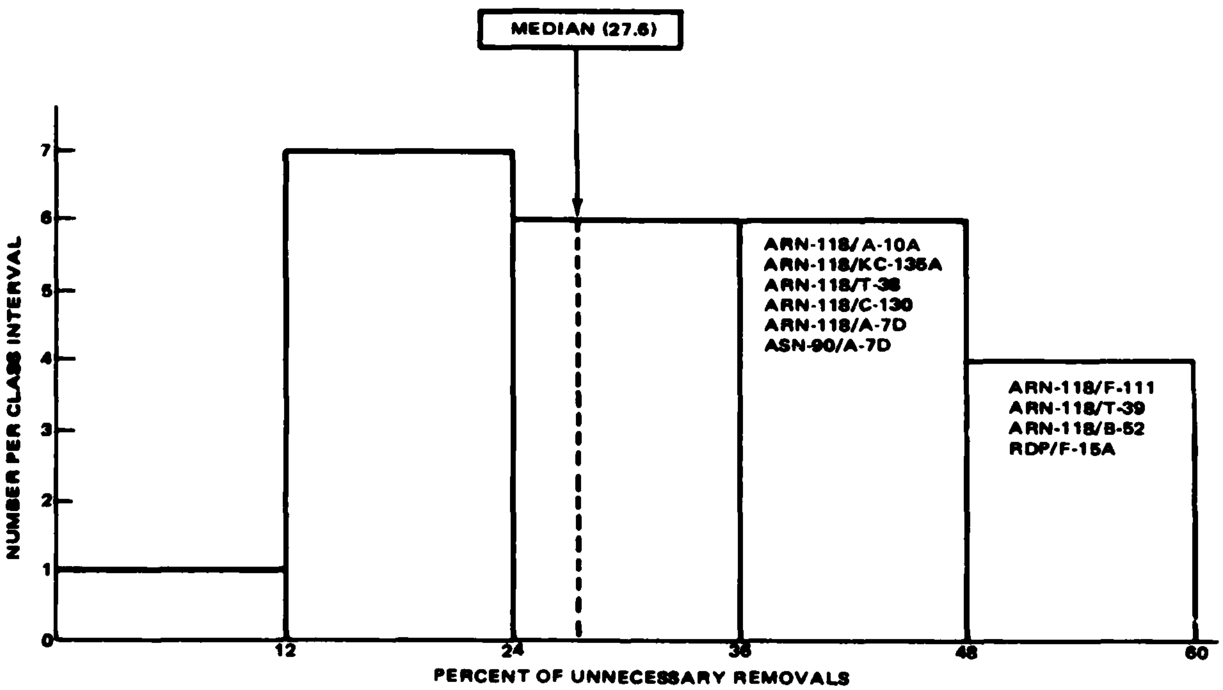

Figure 4. Histogram of the percentage of unnecessary removals.

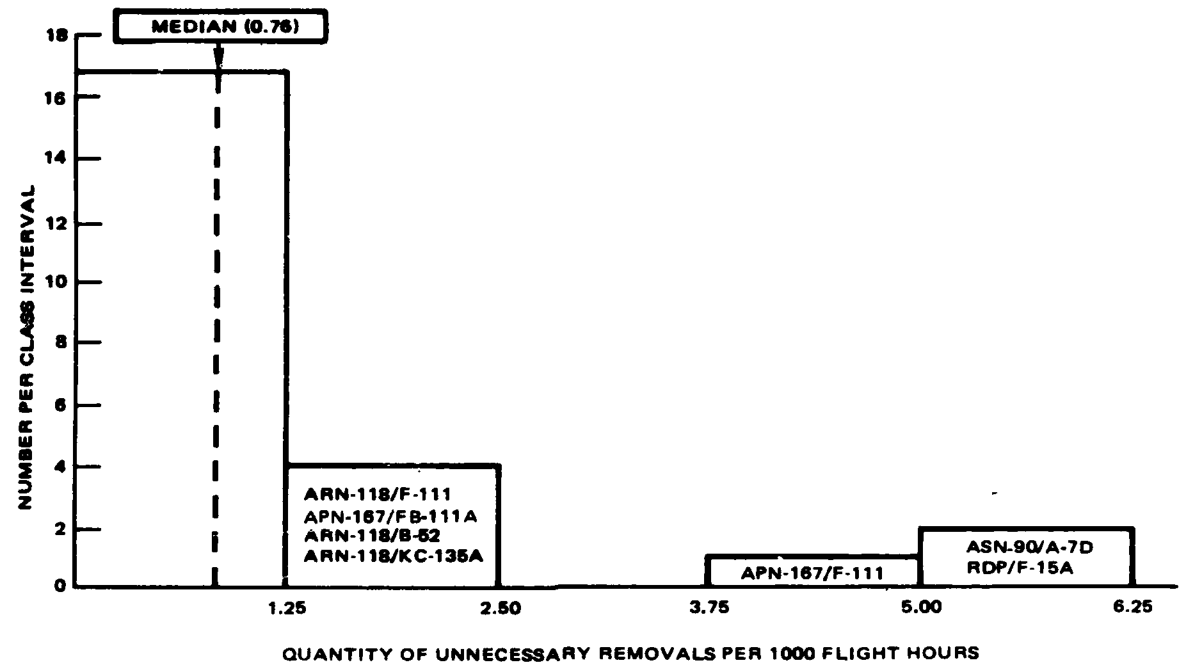

Figure 5. Histogram of the quantity of unnecessary removals per 1000 flight hours.

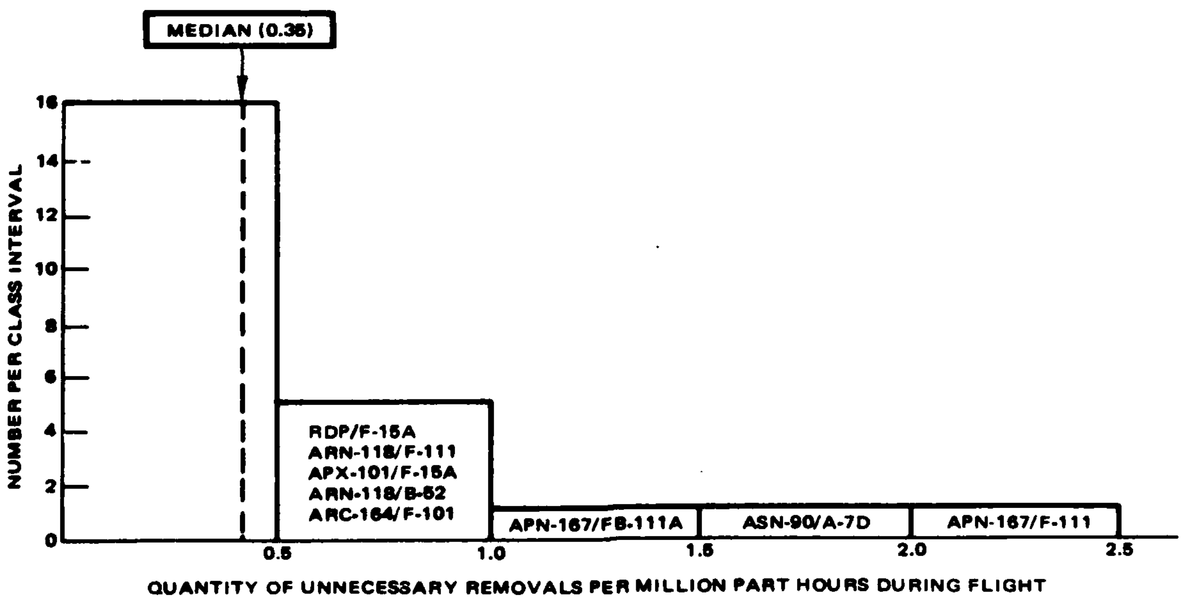

Figure 6. Histogram of the quantity of unnecessary removals per million part hours during flight.

The ASN-90 inaccessibility problem, discussed previously, creates a situation wherein two LRUs are removed even though only one LRU may require repair action. Thus, a high UR rate may result if the maintenance technician does not code such removals to preclude a UR classification in MDC records.

The ASN-90 inaccessibility problem is discussed in a study by the Air Force Flight Dynamics Laboratory (AFFDL). The AFFDL performed short-duration mission-profile tests on eleven ASN-90 Inertial Measurement Units (IMUs) (Ref. 12). Those IMUs had been delivered to a depot with field reported failures. Extensive IMU performance testing at the depot could not detect any failure and the eleven IMUs were classified as RTOK (Re-Test OK). Environmental testing of those IMUs by AFFDL revealed failure modes on seven of the IMUs. The reported field failure mode was duplicated on five of the IMUs, which were temperature sensitive.

In another experiment by AFFDL (Ref. 13), nine IMUs were removed during mission-profile testing. These IMUs were subsequently classified RTOK. In most cases, further testing indicated that the removed IMUs had failed because of temperature sensitivity. (The AR-9 circuit cards in the IMUs were removed and sent to the depot for repair.)

In the case of the APG-63 (RDP)/F-15A, software problems have plagued the RDP (Radar Data Processor), which resulted in several modifications of this equipment. The APN-167 and the ASN-90 have both been in the inventory much longer than any of the other equipments (Table 3). The high UR rate of the latter two equipments may be due to age.

In essence, this review of selected equipment/aircraft data closely correlates the findings in this study. Even though the evaluation of the frequency distribution disproves the arguments that URs are functions of equipment usage and/or complexity, the highlight in the histograms for heavy contributors to the UR rate makes the first order determination of URs less confounding.

Comparison data, related to bomber and fighter aircraft, are shown near the foot of Table 5. The number of equipments, equipment flight hours and percentage of URs for these aircraft types are within 20 percent of each other. On the other hand, the total of URs for fighters are more than 2.5

times the number of URs for bombers. Since the bombers have the larger flight time, both the number of URs per thousand flight hours and the number of URs per mission part hours in flight will be larger for fighters than for bombers.

The comparison noted above involves all of the selected equipments. However, the ASN-90, APX-101 and APG-63 (RDP) are only on fighter aircraft. If these equipments are deleted, a new listing (in the same format as Table 5) is available in Table 6 for further comparison of bombers and fighters.

TABLE 6. BOMBER/FIGHTER COMPARISON DATA

AIRCRAFT TYPE	EQUIPMENT INVENTORY	EQUIPMENT FLIGHT HOURS	TOTAL REMOVALS	TOTAL URs	PERCENT URs	URs/1000 FLT HOURS	URs/MILLION PART HOURS IN FLIGHT
BOMBER	3,870	1,854,164	2,941	820	27.9	0.44	0.30
FIGHTER	3,587	1,237,313	3,533	1,098	31.1	0.89	0.42
(BOMBER/FIGHTER)	1.08	1.50	0.83	0.75	0.90	0.49	0.71

Using Table 6, further review of bomber and fighter aircraft data relating to ARC-164, ARN-118 and APN-167 equipment (which are in both bombers and fighters) results in the following observations:

1. The equipment inventory for bombers and fighters are almost equal.
2. Bombers accumulate more flight hours than fighters: ratio of 1.5 to 1.
3. Bomber inventory and flight hours are slightly greater than fighters, but the number of removals for bombers is noticeably smaller than for fighters. The differences are statistically significant (tests of proportions with a significance level of 0.05 was used in this analysis). There are several reasons for the differences: (a) the environments are more rigorous for fighters than bombers, (b) fighters usually have shorter mission durations, and (c) bomber and fighter organizations may have different maintenance policies.
4. The difference between the number of URs for bombers and fighters is statistically significant, based on either inventory or removals. The reason for this difference, based on inventory, may be due to

(a) equipment which are more reliable on bombers than on fighters, and/or (b) base maintenance policies which are different.

5. The percent UR values are significantly different based on tests of proportions. As there is such a large difference in flight hours, the values in the last two columns of Table 6 are in the expected direction.

A comparison between equipments must be tempered with consideration regarding differences in flight hours, inventory, user aircraft and mission environments. As shown above, bombers have less removals, less URs, and lower percent URs.

4.2.3 Sources of Squawks Resulting in URs

The When Discovered (WD) codes, used in MDC system records, provide computer data useful in determining when malfunction squawks (complaints) were originated. Thus, a tabulation of WD code items related to URs can present visibility of the sources (and quantitative data) of malfunction squawks which resulted in URs.

A review of CY 1978 MDC records involving the six selected equipments in the designated aircraft at specified AFBs visited by the field survey team afforded a listing of 696 WD code items associated with UR events. This listing is shown in Table 7. Three general classifications representing (1) in-flight squawks, (2) between-flight squawks, and (3) after-data-analysis squawks are presented. The frequency (percent) of WD codes in each of the three classifications is also shown in Table 7.

Analysis results indicate that the highest number of URs (73 percent) occurred as a result of in-flight malfunction squawks (generally by aircrews). The next highest number of URs (17 percent) occurred as a result of between-flights malfunction squawks (generally by ground crews and inspectors). The lowest number of URs (10 percent) occurred as a result of after-data-analysis squawks (generally by changes of action-taken classifications, as determined by maintenance data analysts).

TABLE 7. UR "WHEN DISCOVERED" CODES*

When Discovered (Classification)	In-Flight			Between-Flights							After Data Analysis	Total
When Discovered (WD) Code	C	D	P	A	B	F	G	J	M	Q	2	
Quantity	9	498	2	15	32	59	1	4	2	3	71	696
Sub-total	509			116							71	696
Percent	73			17							10	100

EXPLANATION OF WD CODES IN TABLE 7**	
A	Before Flight--Abort
B	Before Flight--No Abort
C	Inflight--Abort. (For aircraft this includes precautionary landings at the home station, intermediate station or final destination as a result of an inflight malfunction)
D	In-Flight--No Abort/During AGE Operation
F	Between Flights--Ground Crew (when not associated with an inspection)During unscheduled Maintenance (AGE)
G	Ground Alert--Not Degraded/AIM 270 Day Checkout/AGM 18 Month Checkout
J	Preflight or Combined Preflight/Postflight Inspection (whichever is applicable).
M	Periodic/Phased/Major Isochronal Inspection (whichever is applicable)/AIM 180 Day Checkout/60 Day GMT Inspection/90 Day Missile-Rocket Trainer Inspection/AGM/TGM 12 Month Checkout
P	Functional Check Flight
Q	Special Inspection
2	During Operation of Malfunction Analysis and Recording Equipment or Subsequent Data Analysis
	**AFM 300-4, Vol.XI, 21 Aug 1978

EXPLANATION OF OTHER WD CODES**	
E	After Flight
H	Basic Postflight. Thruflight or Alert Exercise Postflight Inspection (whichever is applicable) AIM 30 Day-Checkout/AIM 30 Day Storage Inspection
K	Hourly Postflight Inspection/Minor Inspection-Isochronal/AIM 120 Day Checkout/AGM Combined Systems Checkout/AGM 45 Day Check-out
L	During Training or Maintenance on Equipment Utilized in a Training environment (Use only for Class II Training Equipment). This code should be used when recording maintenance or discrepancies on Class II trainers
N	Ground Alert--Degraded/AIM 360 Day Checkout/AGM 24 Month Checkout
R	Quality Control Check
S	Depot Level Maintenance
T	During Scheduled Calibration
U	Non-Destructive Inspection. Includes optical, penetrant,magnetic particle, radiographic, eddy current,ultrasonic,spectrometric oil analysis, etc.
V	During unscheduled Calibration
W	In-Shop Repair and/or Disassembly for Maintenance
X	Engine Test Stand Operation
Y	Upon Receipt or Withdrawal from Supply Stocks
Z	"AGM Under Wing Check - Use of this code for aircraft equipped with MADREC should be limited to discrepancies discovered through analysis of MADREC tape
3	Home Station Check-Isochronal
4	Corrosion Control Inspection
5	Aircraft Interior Refurbishment
6	7-Day Calendar Inspection
	** AFM 300-4, Vol.XI, 21 Aug 1978

*Codes assigned by Air Force maintenance personnel to malfunction events subsequently classified as "unnecessary removal" in 1978 MDC records.

4.2.4 Cost Factors

The cost factors discussed herein are stated in manhours. The predominant UR cost involves labor for the removal of selected equipment from the aircraft plus the testing and inspection in the shop. However, there are other, less obvious, costs involved in URs that cannot be ascertained within the scope of this study. These hidden costs include (1) extra avionic equipment inventories, (2) delays in repairing faulty equipment, (3) holding personnel in standby status, (4) changes in aircraft flight schedules, (5) generating and maintaining malfunction reports in record and computer files, and (6) creating equipment and component malfunctions during removal, bench check and replacement actions.

The USAF Weapon System Effectiveness Program and Models — Logistic Support Cost (LSC) Ranking Segment (AFR 65-110/66-1) provides "management visibility to those items and components which are disproportionate resource consumers" (Ref. 14). The quarterly issue of LSC records lists, under the title "Maintenance Action Summary — K051.PN7M," the average manhours for on-equipment and off-equipment labor (from AFLC Regulation 66-1 MDC computer records). An excerpt is shown, as follows:

K07
WEAPON SYSTEM TO38 SAALC MAINTENANCE ACTION SUMMARY K051.PN7M PAGE 467
AFM 65-110/66-1 DAT \ AS OF 78 DEC DATE PROCESSED 79 FEB 01

			ON EQUIPMENT						OFF EQUIPMENT									
			REPAIRED		EXPENDED		TO SHOP		NRTS		CONDEMNED		NO DEFECT		OTHER		ABORTS	
WUC	NSN	NOUN	UNIT	AV MH	UNIT	AV MH	UNIT	AV MH	UNIT	AV MH	UNIT	AV MH	UNIT	AV MH	UNIT	AV MH	BFA	IFA
638CC	5821006078518	CONTROL, RADIO S																
		FAILURE	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0			2	2.8	0	0
	999999999999999	CONTROL, RADIO																
		FAILURE	10	1.2	0	0.0	2	0.8	0	0.0	0	0.0			0	0.0	0	0
		OTHER	5	0.6	0	0.0	0	0.0	0	0.0	0	0.0	1	1.0	0	0.0		
638CD		POWER SUPPLY ** NO AFM 66-1 DATA **																
638CE	999999999999999	COAXIAL CABLE																
		FAILURE	0	0.0	0	0.0	2	4.5	0	0.0	0	0.0			0	3.0	0	0
		OTHER	9	2.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0		
CD	999999999999																	

An examination of these maintenance action summaries indicates that most applicable figures are obtained by using "On-equipment/To shop," and "Off-equipment/No defect" data. The "To Shop" data records include the total number of units and the average manhours required per removal from aircraft

for all removals (failed or otherwise). At this point, maintenance personnel typically believe any removal to be the result of a failure requiring repair or adjustment. However, since it takes just as long to remove a not-failed item as a failed item, the average manhour cost for removals must be considered in any UR cost evaluation. The "no defect" data records include both the number of units and manhours determined by shop maintenance personnel to be URs, which are included in the total average manhour cost for URs.

The manhour costs of three equipments studied herein are analyzed to determine an average manhour cost to be used in this study. The three equipments are (1) ASN-90 (known to have accessibility problems), (2) ARN-118 (handled under a RIW contract), and (3) ARC-164 (having no known peculiarities). The LSC records for the second and fourth quarters of CY 1978 were reviewed for manhour costs pertaining to the three selected equipments.

The LSC records indicate that the average manhours reported for "To Shop" and "No Defect" actions range from 0.2 to 18 hours per action. To achieve a reasonably accurate average manhour value, the action items were weighted by using the following model for average manhours (Av Mnhrs) per UR for each CY quarter.

$$\begin{matrix}\text{Av Mnhrs} \\ \text{per UR}\end{matrix} = \left[\frac{\Sigma(\text{Units})\ (\text{Av Mnhrs})}{\text{Total Units}}\right]_{\substack{\text{To} \\ \text{Shop}}} + \left[\frac{\Sigma(\text{Units})\ (\text{Av Mnhrs})}{\text{Total Units}}\right]_{\substack{\text{No} \\ \text{Defects}}}$$

The resulting manhour cost per UR for each of the three selected equipments is summarized as follows:

	Av Mnhrs per UR	
Equipment	2nd Quarter	4th Quarter
ASN-90	6.8	8.3
ARN-118	3.8	4.4
ARC-164	5.2	5.2

The average manhour cost, derived from the foregoing listing is about six hours for each UR. Thus, using the total URs (2,965) shown in Table 5,

approximately 17,700 manhours were expended in CY 1978 on the six selected equipments in the inventory. When these costs are combined with the hidden costs discussed earlier, there is a good reason for efforts to reduce the number of URs.

4.3 RELATED STUDIES

Published reports of related studies are reviewed as part of the overall analysis herein. The purpose of the following reviews is to ascertain supplementary and supporting information related to the data in this study.

4.3.1 AMST

The F-15 AMST (Avionics Maintenance System Task) study was performed for ASD/WPAFB (Ref. 7) by the contractor of the single aircraft type studied. The major objective of this study was to identify the causes of Bench Checked-Serviceable (BCS) maintenance events (unnecessary removals) relating to specific avionic LRUs.

Review

The AMST study included a five-month field survey of one AFB and a one-week field survey of a second AFB. The on-site survey team was comprised of a team chief, data specialist, and several maintenance monitors and investigators.

The survey team reported finding 555 O-level maintenance events, of which 239 (43 percent) were classified as Cannot Duplicate (CND). The team also reported 227 I-level maintenance events, of which 69 (30 percent) were classified as BCS (UR). However, the report noted that 11 of the 69 BCS events were lacking various key-information items, and those were eliminated from consideration in the detailed analysis. Therefore, the study concluded that the "actual BCS rate" was 26 percent (rather than the 30 percent noted earlier), based on the revised total of 58 BCS events.

The "most probable factors" (causes) in the generation of the 58 BCS LRUs were listed in the AMST study report as follows:

- Inadequate Troubleshooting 20
- Suspected Intermittent Failures 15

• Improper Reporting (AIS Repair)	6
• Normal Operation	4
• Inadequate Technical Order	4
• Ambiguous Troubleshooting	3
• Technical Order Misinterpretation	2
• Ambiguous AIS Information	1
• Inadequate AIS Troubleshooting	1
• Unprogrammed LRU to Flightline	1
• Bad Writeup	1
	58

Further, the AMST study reported that the four areas providing the largest "contribution" to BCS actions were (1) maintenance management and operations, (2) technician training, (3) operator training, and (4) technical orders. Recommendations designed to eliminate or reduce the BCS rate included:

- Improve Flightline Technician Troubleshooting Proficiency
- Enhance the Quality of Maintenance Debriefing
- Improve AIS Operator Procedures
- Improve Pilot Familiarity with Normal System Operation

The adoption of AMST study recommendations was deemed to have the potential for reducing the BCS rate by 40 to 50 percent.

Comments

The AMST study was limited to the consideration of specified avionic equipment on one particular type of aircraft. One of the LRUs investigated in the AMST study was the Radar Data Processor, which is also investigated in the SCURAE study.

The AMST field survey team remained for a comparatively long period of time at one AFB, which permitted a complete "follow-through" of all BCS (UR) maintenance actions by the members of the survey team. This was in contrast to the average 3-day investigation at each of several AFBs by the SCURAE field survey team.

Some of the reported maintenance problems are unique to the particular AFB investigated by the AMST survey team. The AMST study suggests that some AFB I-level Shop, Supply Control, or Quality Control activity (or inactivity) may contribute to the UR rate.

The AMST study pointed out that I-level maintenance problems included the need to improve I-level shop avionic equipment history records in order that LRUs which repeatedly become UR actions can be sent to the repair depot (along with all historical data) for more extensive testing and possible repair action.

4.3.2 CND Rate Reduction

The CND Rate Reduction study was performed for ASD/WPAFB (Ref. 11). The objective of this study was to conduct a field experiment designed to investigate the effectiveness of using environmental screening as a diagnostic tool to reduce CND (Cannot Duplicate) rates of Air Force avionic equipments.

The acronym "CND," as used in the study, may be a misnomer because the experiment involved avionic equipment already removed from the aircraft for I-level bench check. Such activity in the I-level shop should have been entitled "UR" (Unnecessary Removal) or "BCS" (Bench Checked-Serviceable). The acronym "CND" is normally used to describe the situation where a reported malfunction cannot be verified on the aircraft, and the maintenance technician determines that the suspect equipment need not be removed. Hence, the reader should understand that all "CND" references in the CND Rate Reduction study are to be construed as "UR" or the equivalent "BCS."

Review

The CND Rate Reduction experiment involved the installation of a contractor's prototype of a quasi-random, multi-axis vibration screening facility in the I-level maintenance shop of an AFB, to ascertain the effectiveness of the facility in reducing the UR rates of specified avionic equipments. One equipment was the Radar Data Processor which is included in the SCURAE study.

However, the screening experiment did not accomplish its objective due to a long delay in obtaining serviceable interconnecting cables, and an apparent lack of interest by some AFB maintenance personnel. Nevertheless, some positive data did surface on one group of LRUs. In this case, there were 14 URs reported out of a total of 39 LRUs which were bench checked. However, only seven of the URs were completely processed in the screening facility. The important fact is that three of the seven URs were found faulty in the screening facility. The remaining LRUs continued to be classified as URs.

Comments

Although the CND Rate Reduction study could not provide statistical verification as to the effectiveness of the screening facility, the fact that three out of the seven URs in one group of LRUs processed in the screening facility were found to have malfunctions is a positive indication of the potential of UR rate reduction by environmental screening of suspect LRUs.

An item of interest relating to environmental test equipment is DoD Directive Number 5000.40, Policy Item D8a:

> Actions shall be taken to reduce the percentage of failures that are written off as "false alarms" at all levels of maintenance and repair. Maintenance and repair activities shall be provided with (or if more cost-effective, supported by) test facilities capable of revealing failures that are not found by troubleshooting without environmental stress.

This provision applies from initial delivery through an equipment's final expenditure or removal from the operational inventory.

4.3.3 OIR

The OIR (Operational Influences on Reliability) study was performed for RADC (Ref. 4). The major objective of this study was to identify the influences contributing to reported differences between the required, predicted, engineering-demonstrated and field-observed reliability of avionic equipment.

Review

The OIR study reported that since avionic equipment exposure to shock, acoustic noise, and vibration is generally less on bomber and transport aircraft than on fighter aircraft; the equipment reliability is generally higher on bombers and transports as compared to the same equipment on fighters.

The study also gave the results of a limited analysis of maintenance data, which indicated that 61 percent of maintenance actions are expended on the prime avionic equipment and the remaining 39 percent are expended on system interfaces and associated hardware.

Also, the primary causal factors that relate to the observed differences during various equipment reliability assessments were in the data base used (i.e., the definition of time and failures) and to a lesser extent in the operational influences of maintenance handling and use.

The study also noted that typically some fraction of the maintenance events classified as "failures," in the MDC system, are actually only on-aircraft equipment removal events for which no corresponding shop action record having an action taken (AT) code "B" can be found. In these cases, the computer "automatically" classifies the removal action as a failure, even though the removed equipment may subsequently be found serviceable after I-level bench check (the I-level action being documented with a different JCN). In essence, the computer must be able to match a particular removal action by JCN throughout a reported sequence of maintenance actions in order to identify the actual final AT classification for a removed equipment.

Comments

Some of the avionic equipment and aircraft types investigated (and reviewed in MDC records) by the OIR field survey team are similar to those investigated by the SCURAE survey team. However, the OIR study concentrated on the assessment of causes of on-aircraft "failure" events, in contract to the SCURAE study concentration on the assessment of causes of off-aircraft "non-failure" events (URs).

The MDC problems reported in the OIR study are similar to those encountered during the SCURAE survey. In fact, the ascertainment of the

causes of unnecessary removals (in SCURAE) involved an analysis of matched and unmatched JCNs (as well as identified UR JCNs), as recommended in the OIR study. Further, the ambiguity of some MDC classifications reported in the OIR study were also noted during the SCURAE study. However, meaningful MDC data assessments in both the OIR and SCURAE studies were possible when the approach included correlated information supplied by responsible Air Force management personnel, and those who are responsible for data management and analysis.

4.3.4 NOFRA

The NOFRA (Nonoperating Failure Rates for Avionics) study was performed for RADC (Ref. 5). The objective of this study was to assess the relative significance and magnitude of nonoperating environmental effects on avionic equipment reliability, in relation to predicted and field observed failure rates.

Review

The NOFRA study included a field survey of AFBs and analysis of MDC records to ascertain if "nonoperating failures" have a measurable effect on assessed operational reliability of avionic equipment. The average nonoperating failure contribution, for the equipment studied, was determined as approximately 10 to 30 percent of the total number of failures for typical utilization rates of 20 to 60 hours per month. The conclusion was that only "operating failures" (i.e., failures occurring during in-flight, power-on phases of equipment) should be counted in any mission-oriented failure rate determinations.

One of the recommendations states that any study of the effects of environmental stress on avionic equipment field failure rates should also consider the influence of other factors, such as equipment function and maintenance policy of pertinent operating commands. The study points out that it is not at all surprising that there is considerable variation in the field performance of the same equipments at different AFBs and in different aircraft.

The NOFRA study also recommends that the differences in the maintenance action documentation procedures as implemented by the various operating commands, and/or AFBs, should be further investigated so that the influence of the documentation procedural differences can be accounted for in the performance assessment process by those using the MDC records for studies similar to the one reported in the NOFRA study.

Comments

Some of the avionic equipment and aircraft platforms investigated to the NOFRA study were similar to those investigated in the SCURAE study. However, the NOFRA study is concerned with the assessment of "nonoperating" failures, in contrast to the SCURAE study assessment of the overall "non-failures" (URs). Nevertheless, the MDC processes described in the NOFRA study are similar to the MDC processes used in the SCURAE study.

In general, the SCURAE study considers the influence of equipment function and maintenance policy of pertinent operating commands, as related to URs; and as recommended in the NOFRA study. The degree of variation in field maintenance procedures for the same equipment at various AFBs and depots is investigated in the SCURAE study. The influence of equipment function and maintenance policy is an important factor in any assessment of field maintenance activities, as well as failure rate studies.

An investigation of the influences of differences in the maintenance action documentation is also recommended in the NOFRA study. These differences were observed by the SCURAE field survey team and are documented in the SCURAE report.

4.3.5 BIT False Alarm

This study, entitled Analysis of Built-In-Test (BIT) False Alarm Conditions, was performed for RADC (Ref. 9). The objectives of this study were the investigation and determination of (1) causes of BIT false alarms and the relative frequency of occurrence of each such cause, (2) design guidelines to minimize the occurrences and effects of false alarms, and (3) false alarm rate prediction factors that will provide for the evaluation of alternative BIT designs to determine their susceptibility to false alarms.

Review

A conclusion of the BIT False Alarm study is that current BIT designs have not been optimally matched to system performance, especially under field conditions. This condition is due both to a lack of understanding and appreciation of the severity of the stresses encountered under operational conditions; and to many of the subtleties of how complex systems perform, whether in stressful or benign environments. The latter conclusions are in contrast to the tacit assumption that BIT anomalies can be equated to the need for maintenance (many system anomalies do not indicate failure events requiring maintenance action).

Although detailed analysis of intermittent faults were explicitly excluded from consideration in the BIT False Alarm study, mention was made of the extraordinary similarity between the symptoms of BIT false alarms and intermittent faults. Because of these similarities, intermittent faults are frequently written off as false alarms, and false alarms are frequently misinterpreted as evidence of hidden faults. These two problems were deemed the "root cause" of costly field maintenance. Further research regarding these problems was recommended.

The BIT False Alarm study noted that other studies of the BIT false alarm problem were hindered by a totally inadequate data base, typically based solely on maintenance action reports: often limited only to I-level data. Thus, lack of credibility regarding BIT indications resulted from the fact that "confirming" tests were performed under a totally different environment from that in which the fault was initially detected. In this study, the emphasis was on the most significant characteristic of fault indication: repeatability (i.e., fault indications which occur only one time can generally be written off as false alarms). Most of the data base compiled for this study was collected by contractor personnel and was deemed far superior to any data base that could be compiled from standard military maintenance data systems.

In one of the three systems analyzed, the biggest single type of recommended corrective action was in the software area. However, there was recognition that some anomalous performance may be considered to be a system

characteristic. Such characteristics were deemed to be a major contributor to the false alarm problem. In the second system, BIT was considered too sensitive because tolerances were overly tight — as tight or tighter than factory tests or I-level maintenance limits — and with BIT being overly sensitive to "one time fails" or "short duration faults." In the third system (data from a reliability demonstration test), the vast majority of fault indications were invalid fault messages caused by such things as interference from external RF radiation. For those messages, BIT was correctly identifying anomalous system performance, but such performance was not deemed indicative of the presence of faults.

In general, the category of BIT false alarms which call out a serviceable LRU (instead of indicating the actual failed LRU) was deemed to be largely the result of early, extemporary program policy decisions based on cost or weight saving efforts rather than on a full appreciation of the impact of the support task on combat readiness. Another category of BIT false alarms involves a BIT indication of a failed item which, in fact, is operating properly (i.e., there exists no prime system failure).

The latter category of BIT false alarms was deemed particularly insidious because if the pilot has squawked a fault-free system, the maintenance specialist is obligated to run BIT on the ground; and every time that BIT is run there is some probability that a false alarm will be generated. Thus, momentary "non-fault" anomalies which have been detected via operator observation can lead to BIT false alarms and subsequently to unnecessary maintenance actions (URs). This is also descriptive of true intermittent faults, which are considered inherently difficult to analyze from collected data.

The possible cause of BIT false alarms in the latter category (and the percentage of occurrences in the system analyzed) were listed as follows: (1) Undetermined (30 percent) (representing items for which there were insufficient data to speculate on root causes), (2) System Anomalies (26 percent), (3) Invalid Test (15 percent), (4) Power Transient (12 percent), (5) Environment (8 percent), (6) High Voltage/Transmitter Anomaly (7 percent), and (7) Operator Action (2 percent) (representing incorrect or missed switch settings).

Comments

Although the BIT False Alarm study was limited to analysis of data, collected by contractor personnel, relating to only three systems; the impact of BIT false alarms on the cost of unnecessary maintenance actions is clearly shown. One of the systems investigated contains the RDP LRU which is discussed in the SCURAE study.

In the SCURAE study, the effects of BIT false alarms are included in the discussions relating to aircrew misinterpretation or misjudgment which result in maintenance squawks during post-flight debriefing. Such squawks are deemed discernible by O-level maintenance personnel and therefore should be classified as a CND on the aircraft, rather than found in the I-level shop and classified as a UR. However, the BIT False Alarm study findings are useful supplementary information on BIT problems.

Throughout the BIT False Alarm study, there are discussions regarding the deleterious effects of the operating environment. This can be considered as substantiating evidence for the recommendation in the SCURAE study regarding the need for further investigation into environmental screening of all UR events at the I-level and depot-level maintenance facilities.

The problem of intermittent faults, in contrast to BIT false alarms, are not investigated in the SCURAE study. The reason for such omission is similar to that described in the BIT False Alarm study. In essence, intermittent faults are inherently difficult (if not impossible) to analyze from collected data. A future study of AFB historical data regarding "repeating" and "recurring" malfunction events may be useful in ascertaining a methodology which permits differentiating between false alarms and equipment intermittent conditions, as recommended in the BIT False Alarm Study.

Although the BIT False Alarm study stressed the superiority of contractor-collected malfunction data over standard military maintenance data, the SCURAE study points out that military maintenance data can be useful when analyzed by knowledgeable study personnel, with assistance from field maintenance specialists. However, the SCURAE study agrees that some information (e.g., narratives of symptoms observed by aircrews and ground crews) not available in the MDC system would be very useful if made available for future studies.

The category of BIT false alarms which call out the wrong LRU is discussed in the SCURAE study. This condition is recognized as correctable if pertinent software changes or adjustable BIT tolerances are incorporated in existing hardware. However, the category of BIT false alarms which indicate a fault when, in fact, there is none in the system has a deleterious impact on UR rates. The BIT False Alarm study refers to this category as "momentary non-fault anomalies" which have been detected via operator observation. However, recommended remedial actions may also be useful for non-fault problems, in conjunction with updated on-aircraft and ground maintenance BIT monitoring provisions (e.g., continuous monitoring, BIT data recording, and BIT data filtering). Such monitoring provisions should include BIT detectability of most of the enumerated "root causes" discussed in the last paragraph of the review, above.

As concluded in the BIT False Alarm study, BIT must have the "smarts" built into the design: to distinguish between anomalies which are manifestations of faults and anomalies which must be tolerated as characteristic of fault-free equipment. In general, it is untenable to continue to rely on maintenance specialists for interpretations of BIT indications, which often lead to URs.

4.3.6 BIT Equipment Requirements Workshop

This workshop presentation, entitled Built-In-Test Equipment Requirements Workshop, was prepared for the Assistant Secretary of Defense Manpower Reserve Affairs and Logistics (Ref. 10). The workshop was held for the purpose of assessing progress and problems in specifying and testing BIT used in complex electronic equipment.

Review

The workshop, with both industry and the Services represented, was organized around a case study/discussion format. The following summarizes observations which were consistently made by the various participants during workshop discussions:

- Experience shows that 20 to 40 percent of the items which were replaced because of a failure indication by BIT are later found

to have no failure (principally based on data from both military and civilian aircraft maintenance experience). However, the unnecessary removal rates are not often a part of the requirements.

- Today's state of the art for mechanization of BIT capability is not advanced to the point where the requirement for highly skilled technicians familiar with troubleshooting can be eliminated.
- Early assessment of field operational BIT performance is very difficult because of incomplete software and because of the interactions between operational and maintenance personnel, test equipment and technical manuals. Also, standard Service maintenance data reporting systems do not provide sufficient information to evaluate BIT performance or to solve BIT associated problems.

Some consensus recommendations developed by the working groups include:

- The false alarm rate, which is defined as percentage of operator reported failure indications that cannot be confirmed by maintenance personnel, needs to be considered both in the design and test approach. (There was disagreement among the workshop participants as to whether the rate should be specified at some finite level or zero.)
- The unnecessary removal rate is defined as the percentage of units removed from the system that are found not to contain a failure at higher levels of maintenance. The specific rate to be achieved could be established after the start of the development process.
- Testing (particularly operational tests) and data collection should focus on a 100 percent diagnostic capability. Testing and data collection also should evaluate the specified parameters, namely, the identification of critical failures, the false alarm rate, the percentage of faults detected and isolated automatically or manually and their associated repair times, the unnecessary removal rate, and the adequacy of personnel (need for high skill personnel) considering all maintenance incidents.
- The approaches that could be used to specify, predict and evaluate false alarms and unnecessary removals must be developed.

Comments

The workshop presentation supplements the discussion of BIT in the SCURAE. In essence, the observations and recommendations, noted above, indicate that there is much improvement to be made in the areas of specifying, verifying and testing BIT and other diagnostic tools.

In respect to unnecessary removals and BIT false alarms, some workshop participants suggest that these conditions be eliminated ultimately. However, there was a question as to whether a "complete program" was affordable. Nevertheless, there was agreement that some sort of "closed loop" data collection system is necessary to measure BIT effectiveness and to ascertain a valid baseline for corrective action (such a system is not currently available for most avionic equipment). Such a system must include on-site personnel to collect data, follow-up problem areas, and effect a solution.

In general, the discussions regarding unnecessary removals closely corroborated the discussion in SCURAE. Although much discussion centered on the issues of contractor design and development of "smart BIT," there was acknowledgement that current approaches to BIT system design do not take into account many "real world" problems; as evidenced by high levels of false alarms, undetected failures, unnecessary removals and ambiguities. There was agreement that during the process of system definition, the optimum "diagnostic" system should be defined within the user constraints consisting of automatic and manual diagnostic capabilities. This system is deemed to consist of BIT, people, T.O.s and test equipment.

5.0 CONCLUSIONS

The following conclusions are based on field survey team observations, review of maintenance data, results of analyses and review of related studies.

I. Nine causes of URs were found in this study (Table 4). These causes encompass the diagnostic elements (i.e., human and machine factors) of avionic equipment maintenance technology. The following listing of the causes are ranked in descending order, as to percentage of UR occurrences:

1. Ineffective Built-In-Test (BIT) (22 percent)
2. Ineffective or Missing Test Equipment (18 percent)
3. Ineffective Supervision/Support (16 percent)
4. Ineffective Technical Orders (13 percent)
5. Inaccessibility (12 percent)
6. Management Directives (7 percent)
7. Test Equipment Differences (7 percent)
8. Inadequate Skill (5 percent)
9. Inadequate Feedback (1 percent)

II. BIT, on some fielded equipment, is not optimally matched to system performance. This situation is evident when operator interpretations of BIT indications are necessary. Further, the lack of field maintenance documentation of BIT problems hinders analyses and corrective actions needed to effectively reduce those problems (e.g., unnecessary removals).

III. Many of the causes of URs are related to flightline "nonstandard" troubleshooting practices. These practices include "shotgun" fault isolation, and "trial-and-error" or "substitution" by removal and replacement of suspect avionic equipment. Such practices tend to mask the actual cause(s) or URs and, therefore, can preclude corrective action.

IV. The average UR rate for CY 1978 is 32.7 percent of all removal of avionic equipment from aircraft to repair shops. However, the uniqueness and variability of different avionic equipment must be understood in any analysis or discussion of average UR rates.

V. The range of UR rates of different avionic equipment depends largely on the environments of different aircraft platforms and maintenance policies at different AFBs.

VI. URs are not a function of equipment usage or equipment complexity.

VII. Hidden faults traceable to component environmental sensitivity are difficult to detect. An efficient method for such detection is the use of temperature-vibration chambers at I-level facilities. This conclusion is based on an experiment where three of seven avionic equipments, classified as URs, were found to have valid malfunctions during environmental testing (Ref. 11); and on similar results of experiments completed by AFFDL (Refs. 12 and 13).

VIII. In the study, an analysis of maintenance cost factors resulted in finding that the average manhour cost of a UR is about six hours. However, the associated hidden costs (e.g., additional avionic spares, delays in test and repair of faulty equipment, creating equipment malfunctions during UR activities) can substantially increase the total average cost of URs.

6.0 CORRECTIVE ACTIONS

Feasible methods for minimizing the adverse effects of the three most frequently occurring causes of URs are presented in the following paragraphs. These three causes are described, in Paragraph 4.1.2, as the most likely candidates for such corrective action.

6.1 INEFFECTIVE BIT

In general, the adverse effects of ineffective BIT on UR rates can be minimized by improvements in the areas of (1) BIT design and development, specifications, and (2) BIT verification capabilities. For the purposes of this discussion, BIT verification is narrowly defined as the process for identifying BIT problems related to false alarms and URs.

1. BIT design and development specifications must account for false alarms, undetected failures, unnecessary removals and system ambiguities (see Paragraphs 3.2.6.3, 4.3.5 and 4.3.6).

   Also, the severity of stresses encountered under operational conditions must be fully considered in BIT specifications. For example, BIT can be too sensitive (tolerances overly tight) to "one-time faults" or "short-duration faults." These conditions are deemed correctable by incorporating software changes or adjustable BIT tolerances into existing and new designs.

   BIT specifications should also include requirements for "smart" BIT. For example, BIT should distinguish between anomalies which are manifestations of faults, and anomalies which must be tolerated as characteristic of fault-free equipment. In the latter, BIT discernments would greatly aid in minimizing the occurrence of URs. At present, BIT operators often find it necessary to use their personal logic to interpret anomalous BIT indications (References 6-10).

2. BIT verification capability would be enhanced by a data collection system designed to fully record BIT development and field experiences. At present, standard Service maintenance data collection systems do not provide such BIT data for most avionic equipments.

A record (narrative) of the symptoms interpreted as BIT-related faults by aircrews and ground crews would aid in establishing specific corrective actions. Such actions, in turn, could aid efforts to minimize the occurrence of BIT-related URs. However, in this approach to BIT problems, an issue of cost arises because of the necessary requirement to have on-site personnel collect the specific data, follow-up problem areas, and effect a solution. BIT verification capability also involves additional types of test equipment (e.g., flightline suitcase testers to supplement BIT, portable environmental screening testers to simulate operating environments). Such test equipments are deemed useful for finding equipment malfunctions which cannot be otherwise determined by existing BIT or ATE (References 6, 9-11). The ability to find such "hidden" malfunctions would aid in minimizing the occurrences of BIT-related URs.

6.2 INEFFECTIVE OR MISSING TEST EQUIPMENT

The adverse effects of ineffective or missing test equipment on UR rates can be minimized by rectifying certain field maintenance practices and conditions which create the need to bypass the use of specified test equipments. This aspect of test equipment problems, reported in this study and detailed in the Field Survey Report Excerpts (Appendix B), is discussed in the following paragraphs.

1. Specific test equipment requirements are delineated in T.O.s. Thus, maintenance personnel are expected to use specified test equipment to perform specific functions at each level of maintenance. However, the field survey team found that certain unwieldy test equipments were sometimes not used, as required, during troubleshooting and repair of some avionic equipments. Also, the field survey team found that some test equipments are not available. These situations point out (1) that a study should be performed as to the cost effectiveness of procuring modern test equipment to replace outdated test equipment, and (2) the need for ensuring that needed test equipment is always available.
2. Attributes of good test equipment must be considered prior to the acquisition of new test equipment or modification of existing equipment. An example of good test equipment is a modern test set (APM-424) designed for the IFF system. This test set is a small, light-weight, hand-carried, battery-powered unit which provides complete checkout of all transponder systems. The use of this test set enables one man to perform a test in less than one minute. Because of the simplicity of operation, operator training is minimal. The acquisition or modification costs of the test equipment discussed herein must be considered together with a full appreciation of the impact of such supporting equipment on combat readiness, as well as the cost of URs.

6.3 INEFFECTIVE SUPERVISION/SUPPORT

The adverse effects of ineffective supervision/support on UR rates can be minimized by increasing maintenance supervisors' understanding of the impact of URs on field maintenance schedules, time and costs. During the field survey team interviews with flightline maintenance personnel and flight-crews, some personnel expressed that they did not recognize URs as a problem worthy of corrective actions.

In general, ineffective supervision/support involves the need for more control of the work habits of maintenance technicians. Although a lack of supervision support may be the result of the current short supply of middle management personnel, special attention of supervision is necessary to decrease the occurrence of nonstandard troubleshooting practices and reporting deficiencies, which impact the UR rate. However, such supervision actions may require motivation based on an understanding that URs are also problems which directly impact operational readiness.

1. Nonstandard troubleshooting is condoned by maintenance supervisors in the interest of keeping aircraft flying, generating high operational readiness rates, and minimizing turnaround times.

   At O-level maintenance; "shotgun", "trial-and-error", and "substitution" troubleshooting is employed for LRU fault isolation. Such practices may sometimes be required, as when priority sorties dictate that the timeliness of aircraft flights is of greater utility than the use of standard maintenance procedures to fault isolate reported malfunctions of avionic equipments. However, maintenance supervision should not permit such practices to continue beyond the time of need, in the interest of flight safety, as well as efforts to mininize the occurrence of URs.

   In addition, the UR rate can be expected to increase when standard troubleshooting procedures (T.O.s) are circumvented to effect a quick return to flight status of an aircraft experiencing a suspected malfunction. In essence, there is a need for increased attention by maintenance supervision to ensure that the technicians' work habits conform with requirements (i.e., maintenance tasks "by the book"). In some cases, it may be necessary for supervision to establish more stringent control techniques.

2. Accurate documentation of maintenance actions is necessary to ensure complete traceability of avionic equipment malfunctions. Such traceability enables analysts to pinpoint avionic equipments which experience recurring and/or excessive URs. In this way, specific equipment/aircraft platform combination problems become visible and corrective actions can be initiated. Special attention by maintenance supervisors to ensure accurate maintenance-document entries by technicians is deemed an important necessity.

Management visibility of problem (e.g., URs) trends is largely dependent on the accuracy of maintenance records. Such visibility is a first step in the allocation of resources to effect corrective actions (e.g., minimizing the occurrence of URs). Thus, the extra supervision/support necessary to ensure such visibility must be considered. The cost of this extra supervision/support is deemed to be negligible.

7.0 RECOMMENDATIONS

I. The Air Force should initiate an in-depth study into the problem of nonstandard troubleshooting practices. For example, two squadrons (experiencing high UR rates) could be singled out for a time-limited experiment (e.g., three months). During this period, it would be mandatory that all maintenance will be performed "by the book." BIT instructions would be explicitly followed, Technical Orders would be rigorously followed, and prescribed test equipment would be utilized at organizational and intermediate levels. Care would be taken to keep accurate data records. This study would be different from previous AFB studies insofar that all pertinent, formal Air Force maintenance documents (procedures) would be rigorously pursued (i.e., variant local directives could be temporarily suspended).

If the results of the experiment indicated a dramatic improvement in maintenance efficiency, then the Air Force would have confidence that the problem of URs could be greatly reduced by training maintenance personnel to abide by standard maintenance procedures. (In this case, the fundamental problem may be a "people problem".)

If the results indicated deficiencies in the diagnostic tools (e.g., BIT, ATE) provided to maintenance personnel, the Air Force should take appropriate steps to improve the tools, with testability in mind. (In this case, the fundamental problem may be a "hardware problem".)

If the results were inconclusive, this would indicate the need for more fundamental studies into ways to improve maintenance effectiveness. Such studies could include determination of ways for improving communications and other human factor areas, or ways to identify the need for additional types of test equipment (e.g., flightline suitcase testers to supplement BIT).

II. The Air Force should initiate directives needed to delineate the techniques to be used in minimizing the causes of URs. Although the development of some feasible techniques may be dependent on the results of other recommendations discussed in this section, timely action should be considered for the three most frequently occurring causes of URs (56 percent) discussed in Section 6.0. The following paragraphs list some techniques relating to those three causes of URs.

Techniques for minimizing "Ineffective BIT" as a cause of URs should involve requirements for (1) fault isolation to a single LRU at flightline and a single SRU at repair shop (e.g., BIT detectors - microprocessors - at LRU interfaces), (2) commonality

of maintenance testing (e.g., use of "identical" in-flight BIT malfunction data and conditions during flightline, repair shop and depot troubleshooting), (3) flexibility of BIT tolerances (e.g., capability for tightening tolerances during ground-BIT troubleshooting), (4) warrantable false alarm rates and BIT-related UR rates (e.g., establishing conditions similar to RIW contracts), and (5) closed-loop BIT data collection (e.g., developing a system to fully record BIT field experiences and evaluate specified BIT parameters).

Techniques for minimizing "Ineffective or Missing Test Equipment" as a cause of URs should involve requirements for (1) special joint reviews by contractor and user personnel of specific test equipment known to be ineffective (not used as required) or missing at repair sites (e.g., developing a procedure whereby pertinent information from established Air Force audits and personnel-suggestions documents are reviewed to determine quick-response actions for T.O. revision, test equipment modification, or acquisition of needed cost-effective test equipment), (2) specifying alternative test-start points in T.O.s for more effective use of test equipment (e.g., certain fault-isolation tests can sometimes be quickly and cost effectively completed by starting the test at some midpoint in the T.O. procedure -- rather than always starting the test at the beginning of the T.O., as specified), and (3) specifying that new test equipment acquisition feature ease of transportation, ease in setup, fast maintenance test time, self-test capability, and commonality with test equipment used at all levels of maintenance.

Techniques for minimizing "Ineffective Supervision/Support" as a cause of URs should involve requirements for (1) more stringent personnel control methods (e.g., nonstandard troubleshooting methods are sometimes the result of poor personnel habits which can be corrected by appropriate supervision control), (2) ensuring effective feedback of maintenance information from I-level shops to O-level personnel (e.g., the maintenance tasks of O-level personnel can be relieved if they become knowledgeable about the outcome of their decision to send avionic equipment to I-level repair shops), (3) accurate documentation of maintenance actions at all levels (e.g., maintenance management visibility of problems is enhanced when accurate data is analyzed and reviewed), and (4) single supervision responsibility for both O-level and I-level maintenance functions (e.g., one supervisor can more effectively assign I-level specialists to assist O-level personnel with specific, urgent problems).

III. The Air Force should initiate a study into the area of detecting and isolating hidden faults (e.g., environmentally sensitive components). The investigation of such problems was beyond the scope of this study. Although some studies have already been performed into the feasibility of using small environmenal chambers at the intermediate level of maintenance, more study is needed. The objective would be to develop environmental tests for exposing suspect avionic equipment to the environmental stresses experienced during aircraft missions.

IV. The Air Force should initiate a study of the trends of UR rates at CONUS AFBs. Such study should review the annual experience (e.g., CY 1979 to present) of URs in comparison with that presented in this study. The results of a study of trends can indicate whether there has been improvement or otherwise.

V. The Air Force should initiate a study of the cost impact of URs. The cost of URs should be explored in depth. Also, a trade-off analysis should be performed relating to the cost of URs versus the cost of preventing all URs. Such analysis can provide maintenance management with the visibility needed for decision making.

8.0 ACRONYMS AND ABBREVIATIONS

A/C	Aircraft
AF	Air Force
AFB	Air Force Base
AFM	Air Force Manual
AFR	Air Force Regulation
AFS	Air Force Station
AIS	Avionics Intermediate Shop: Repair shop (I-level) at AFBs, where equipment removed at the flightline (O-level) is tested and repaired.
ALC	Air Logistics Center
AMS	Avionics Maintenance Squadron
AMU	Avionics Maintenance Unit
ASD	Aeronautical Systems Division
AT	Action Taken Code: The action taken code is used to identify the maintenance action that was taken, such as remove and replace. Action taken codes are standard for all equipment and are listed in all work unit code manuals. A complete list of authorized Action Taken codes is contained in AFM 300-4, Volume XI.
ATC	Air Training Command
ATE	Automatic Test Equipment: Usually located at the I-level or the Depot-level of maintenance.
ATS	Automatic Test Station: Same as ATE
BCS	Bench Checked - Serviceable: Equipment which is tested and found to be usable "as is," without further action at I-level.
BIT	Built In Test: BIT includes all of the special circuitry and software designed into an avionic system to verify that the system is operative or, if the system is indicated to be not fully operative, to isolate the fault to an element of the system which can be removed and replaced to correct the condition.
BLIS	Base Level Inquiry System
CMPTR	Computer
CND	Cannot Duplicate: A reported discrepancy which cannot be duplicated (or verified) upon retest at O-level.
COMM/NAV	Communication/Navigation
CONUS	Continental United States

CRS	Component Repair Squadron
CY	Calendar Year
DCASMA	Defense Contracts Association Support Material Area
DCM	Deputy Commander for Maintenance
DIFM	Due-In-For-Maintenance
HOW MAL	How Malfunctioned Code: The How Malfunctioned code is used to identify how the equipment malfunctioned, such as "cracked." To provide maximum utility, these codes are also used to identify time compliance technical order status requirements, or to show that a maintenance action did not result from a defect. A complete list of authorized How Malfunctioned codes is contained in AFM 300-4, Volume XI. How Malfunctioned codes are listed in each Work Unit Code Manual for each individual type of equipment in both alphabetic and numeric order.
I-LEVEL	Intermediate Level of Maintenance: For avionic systems, intermediate level maintenance includes all base-level maintenance performed at locations other than at the aircraft. It includes performing checks and corrective maintenance on LRUs and may include performing bit-and-piece repair on SRUs.
IFF	Identification - Friend or Foe: Avionic equipment
IMU	Inertial Measurement Unit
INS	Inertial Navigation System
IROS	Increased Reliability of Operational Systems: The USAF Logistic Support Cost reporting system implemented by AFLC Regulation 400-16.
JCN	Job Control Number: The number assigned at the start of a specific maintenance task, and recorded on pertinent documents. The JCN provides traceability of all maintenance actions subsequent to the original issue.
LARA	Low Altitude Radar Altimeter
LRU	Line Replaceable Unit: An LRU is an element ("black box") of an avionic system which can be removed and replaced by organizational level maintenance personnel. LRUs which are faulty or suspect are removed from the aircraft and replaced with operative LRUs. The removed LRU is sent to an intermediate level shop for maintenance.
LSC	Logistics Support Cost
MAC	Military Airlift Command
MDC	Maintenance Data Collection (System): Described in AFR 66-1.
MDR	Maintenance Deficiency Report

MTBF	Mean-Time-Between-Failures
NRTS	Not Repairable This Station: Identifies an item of hardware which, for any or a variety of reasons (including policy, technical, and economic), is not designated to be repaired at base level.
O-LEVEL	Organizational Level of Maintenance: Maintenance performed by a using organization on its own equipment. For avionic equipment, organizational maintenance is performed at the aircraft.
OJT	On the Job Training
PCB	Printed Circuit Board
POMO	Production Oriented Maintenance Organization: Described in AFR 66-5 and employed by TAC.
PRAM	Productivity, Reliability, Availability and Maintainability (AF Organization)
PSA	Power Supply Adapter
R/T	Receiver/Transmitter
RAAC	Repairable Aircraft Asset Center
RADC	Rome Air Development Center
RCM	Repair Cycle Monitor
RCVR	Receiver
RDP	Radar Data Processor
REMS	Removals: The number of maintenance actions coded as removed for the equipment as reported in the MDC data analysis summaries by WUC.
RIW	Reliability Improvement Warranty: An equipment purchasing concept in which the equipment manufacturer is responsible for all depot level equipment repair for an agreed-upon period of time.
RTOK	Retest OK: Generally used at the depot-level to indicate that the equipment was tested and found serviceable without repair or adjustment.
SAC	Strategic Air Command
SCURAE	Study of the Causes of Unnecessary Removals of Avionic Equipment
SRU	Shop Replaceable Unit: A generic term which includes all the packages within an LRU, including chassis and wiring as a unit. Conversely, an LRU is composed entirely of SRUs.

TAC	Tactical Air Command
T.O.	Technical Order
TRC	Technical Repair Center
UHF	Ultra High Frequency
UR	Unnecessary Removal: Refers to the removal from aircraft platforms of those LRUs and equipment that have no apparent defect in them when corrective maintenance is attempted at repair facilities.
USAF	United States Air Force
WD	When Discovered: The When Discovered code is used to identify when a discrepancy requiring maintenance action was discovered, such as during a quality control inspection. When Discovered codes are listed in each work unit code manual for individual types of equipment.
WPAFB	Wright-Patterson Air Force Base
WR-ALC	Warner Robins Air Logistics Center
WUC	Work Unit Code: The work unit code consists of five characters, and is used to identify the system, subsystem, and component on which maintenance is required or on which maintenance was accomplished. These codes are published in work unit code manuals for each weapon and support system. The first two positions of the work unit codes for aircraft identify functional systems, such as flight control system, antenna system, or launch control system. The third and fourth positions of the work unit code identify subsystem or major assembly. The fifth position of the work unit code normally identifies repairable items.
XMTR	Transmitter
XPDR	Transponder

9.0 REFERENCES

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APPENDIX A

FIELD SURVEY REPORT FORM

STUDY OF THE CAUSES OF UNNECESSARY REMOVALS

FIELD SURVEY REPORT

APPENDIX A

DATE:

EQUIPMENT IDENTIFICATION		
AVIONICS SYSTEM:	AN/DESIGNATOR:	WORK UNIT CODE:
FUNCTION		
AIRCRAFT	EQUIPMENT TIME IN SERVICE:	
DESCRIPTION OF WEAPON SYSTEM MISSION:		
DESCRIPTION OF SUBSYSTEM CAPABILITIES:		
WEAPON SYSTEM AVERAGE FLYING HOURS PER MONTH:	SUBSYSTEM AVERAGE FLYING HOURS PER MONTH:	
SUBSYSTEM GROUND OPERATING TIME PER FLIGHT HOUR:	NUMBER OF LRUs PER SUBSYSTEM:	
LRU NOMENCLATURE/PART NUMBER:		
QUANTITATIVE VALUES:		
(1) MTBF:	(2) MTBM:	(3) MMH/FH:
(4) MTTR:		

STUDY OF THE CAUSES OF UNNECESSARY REMOVALS

FIELD SURVEY REPORT

APPENDIX A

DATE:

EQUIPMENT IDENTIFICATION (cont)
ACCESSIBILITY OF SUBSYSTEM LRUs ON AIRCRAFT:
DESCRIPTION OF SUBSYSTEM ON AIRCRAFT TEST AND MONITORING EQUIPMENT:
QUALITATIVE FEATURES:
COMMENTS:

STUDY OF THE CAUSES OF UNNECESSARY REMOVALS

FIELD SURVEY REPORT

APPENDIX A

DATE:

MAINTENANCE CONCEPTS EMPLOYED		
LEVEL OF MAINTENANCE STRUCTURE:	TWO TIER	THREE TIER
DESCRIPTION OF ORGANIZATION LEVEL MAINTENANCE:		
DESCRIPTION OF INTERMEDIATE LEVEL MAINTENANCE:		
DESCRIPTION OF DEPOT LEVEL MAINTENANCE:		

STUDY OF THE CAUSES OF UNNECESSARY REMOVALS

FIELD SURVEY REPORT

APPENDIX A DATE:

DEBRIEFING
DESCRIPTION OF THE DEBRIEFING FUNCTION:
WHERE ARE DEBRIEFINGS CONDUCTED:
WHEN ARE DEBRIEFINGS CONDUCTED:
HOW ARE DEBRIEFINGS CONDUCTED:
DESCRIBE THE DEBRIEFING PROCEDURE:
WHO CONDUCTS THE DEBRIEFING: MAINTENANCE SPECIALIST/AIRCREW/OPERATOR
WHO ATTENDS THE DEBRIEFING:
ARE REPEAT/RECURRING FAILURES IDENTIFIED:
DESCRIBE DATA FLOW AND RECORDS/FORMS:

STUDY OF THE CAUSES OF UNNECESSARY REMOVALS

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DATE:

DESCRIPTION OF FUNCTIONAL CHECKS
PRE-FLIGHT:
IN-FLIGHT (FLIGHT CREW CHECK):
POST-FLIGHT:
COMMENTS:

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DATE:

OTHER MAINTENANCE CHARACTERISTICS
INSPECTION REQUIREMENTS:
DESCRIPTION OF SUBSYSTEM DESIGN CHARACTERISTICS FOR MAINTENANCE:
DESCRIPTION OF SPECIAL MAINTENANCE AIDS OR LOCAL MODIFICATIONS:
COMMENTS:

STUDY OF THE CAUSES OF UNNECESSARY REMOVALS

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TROUBLESHOOTING METHODS
DESCRIPTION OF ORGANIZATIONAL TROUBLESHOOTING METHODS:
DESCRIPTION OF INTERMEDIATE TROUBLESHOOTING METHODS:
DESCRIPTION OF DEPOT TROUBLESHOOTING METHODS:

STUDY OF THE CAUSES OF UNNECESSARY REMOVALS

FIELD SURVEY REPORT

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DATE:

AGE (VERTICAL AND HORIZONTAL COMMONALITY)
ORGANIZATIONAL LEVEL AGE:
INTERMEDIATE LEVEL AGE:
DEPOT LEVEL AGE:
COMMENTS:

AD-A127 546 STUDY OF THE CAUSES OF UNNECESSARY REMOVALS OF AVIONIC EQUIPMENT..(U) HUGHES AIRCRAFT CO EL SEGUNDO CA ELECTRO-OPTICAL AND DATA SYS.. H D RUE ET AL. JAN 83 2/3

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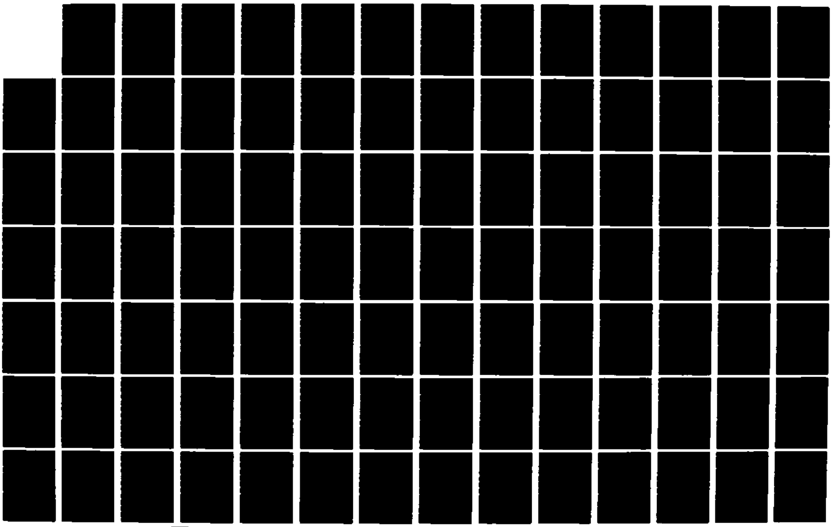

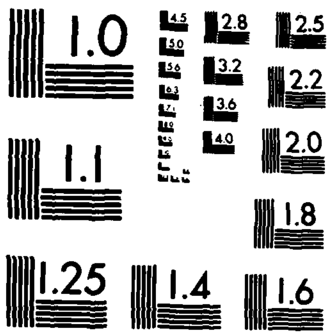

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

STUDY OF THE CAUSES OF UNNECESSARY REMOVALS

FIELD SURVEY REPORT

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DATE:

OTHER CONTRIBUTING FACTORS
TECHNICAL ORDERS:
TRAINING AND PERSONNEL SKILL LEVEL (DESCRIPTION OF SKILL REQUIREMENTS):
MAINTENANCE DATA COLLECTION DOCUMENTATION AND FEEDBACK SYSTEM (GENERAL DESCRIPTION):

STUDY OF THE CAUSES OF UNNECESSARY REMOVALS

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OPERATIONAL FACTORS CONTRIBUTING TO UNNECESSARY REMOVALS

	LOW 1	2	3	4	5 HIGH
• SHORT REACTION, OPERATIONAL READINESS INSPECTIONS, LAUNCH AIRCRAFT SYSTEM FAILURES:	○	○	○	○	○
• AIRCREW/SUPERVISORY PRESSURE:	○	○	○	○	○
• TIME OF DAY, SHIFT CHANGE:	○	○	○	○	○
• ABILITY OF MAINTENANCE TO REPRODUCE THE ACTUAL OPERATIONAL ENVIRONMENT WHEN ATTEMPTING TO VERIFY AN EQUIPMENT FAILURE:	○	○	○	○	○

COMMENTS:

STUDY OF THE CAUSES OF UNNECESSARY REMOVALS

FIELD SURVEY REPORT

APPENDIX A DATE:

CONTINUATION PAGE

STUDY OF THE CAUSES OF UNNECESSARY REMOVALS

FIELD SURVEY REPORT

APPENDIX A

DATE:

BASE AND PERSONNEL CONTACTED	
BASE:	LOCATION:
ORGANIZATION	DATE VISITED:

PERSONNEL

NAME	RANK	ORGANIZATION	TELEPHONE	MAILING ADDRESS	DATE CONTACTED

APPENDIX B

FIELD SURVEY REPORT EXCERPTS

(Ordered by AFB Codes A-L)

FIELD SURVEY REPORT EXCERPTS

A36 **DATE:** 12-4-79 CAUSE NO. 6

AFB: A	**AIRCRAFT:** KC-135	**AN/DESIGNATOR:** ARC-164/UHF Radio

DEBRIEFING OBSERVATIONS

Debriefing accomplished about 30 minutes after A/C recovery. Aircrew completes AFTO Form 781. Thereafter, SAC Form 126 and SAC Form 77 is completed and used as a checklist. Debriefer completes AFTO Form 349 for reported malfunctions, with aid of AMS shop representative. Repeat/recurring failures are identified.

O-LEVEL OBSERVATIONS

Performs on-A/C verification of squawks. Removes suspect LRU and accomplishes replacement. Suspect LRU is routed to I-level. O-level support test equipment are referenced in T.O.s, but are not used. Troubleshooting consists of attempted operation, removal, bench check and replace; or by substitution.

I-LEVEL OBSERVATIONS

Performs fault isolation of suspect LRU to SRU level by test using hot mock-up. Faulty SRU is routed to depot for repair. When any LRU is considered "beyond capability of maintenance," it is routed to depot for repair. I-level radio shop does not file 799-B (UR) actions or 799-H (CND) actions.

RECORDS AND FORMS USED

Copies of AFTO Form 781, AFTO Form 349 and SAC Form 126 are sent to Job Control, AMS and Production Analysis. AFTO Form 349 is maintained in I-level shop (copy is sent to AMS Analysis for A/C history file). AMS Analysis files 799-B actions by A/C number on AFTO Form 95, however, avionics removal versus BCS traceability can be lost because JCNs are frequently omitted during transcriptions.

COMMENTS

A typical KC-135 post-flight write-up will average about ten squawks by the aircrew.

FIELD SURVEY REPORT EXCERPTS

A22 **DATE:** 12-4-79 CAUSE NO. 4

AFB: A	**AIRCRAFT:** KC-135	**AN/DESIGNATOR:** ARN-118/TACAN

DEBRIEFING OBSERVATIONS

Formal debriefing with flight crew, maintenance specialist and debriefer is held within 30 minutes after landing. Debriefing follows a checklist (SAC Form 77). The aircrew completes AFTO Form 781 prior to debriefing. Repeat and recurring failures are maintained by debriefing group on SAC Form 126 (history of six sorties): checked at each debriefing.

O-LEVEL OBSERVATIONS

BIT, operable from the cockpit, provides Go/No Go system check. Troubleshooting is conducted using BIT, flightline test equipment and operational TACAN station. Primary troubleshooting is removal of LRUs and sending them to I-level for bench check, since unwieldly test equipment is not used for all malfunction verifications. AFTO Form 349 for O-level actions are discarded after data are inputted to MDC system.

I-LEVEL OBSERVATIONS

Bench check consists of use of test equipment and hot mock-up. LRUs found faulty are NRTS to contractor depot for test and repair under the terms of RIW contract. I-level maintains SAC Form 126 for history of last five sorties of each aircraft. All AFTO Form 349 documents are forwarded to the MDC section for input to MDC system and to Squadron Analysis section. The Communication shop discards I-level AFTO Form 349 coded 799-B (UR).

RECORDS AND FORMS USED

AFTO Form 781 completed by aircrew. AFTO Form 349 and SAC Form 126 are completed at debriefing and copies are forwarded to Plans and Scheduling, and Job Control. The discrepancies are dispatched by Job Control to the respective maintenance shops on AFTO Form 349. Aircraft history is maintained by the AMS Analysis section on AFTO Form 95 (one year).

COMMENTS

Feedback from I-level to O-level is very good (both are located in the same area), but feedback from depot is only on documentation errors.

FIELD SURVEY REPORT EXCERPTS

A34 **DATE:** 12-4-79 CAUSE NOS. 2,5,6

AFB: A	**AIRCRAFT:** B-52D	**AN/DESIGNATOR:** ARC-164/UHF Radio

DEBRIEFING OBSERVATIONS

Aircrew completes AFTO Form 781 and this is supplemented with SAC Form 126. Debriefing accomplished about 30 minutes after touchdown. Debriefer completes AFTO Form 349 with aid of AMS shop representative. SAC Form 77 is a checklist used to supplement information to affected maintenance shop. A typical B-52 debrief write-up averages about 25 squawks (as compared with 10 squawks for a typical write-up of a KC-135).

O-LEVEL OBSERVATIONS

"Dispatch crew" handles squawks at the flightline by attempts to duplicate discrepancy on A/C, or remove and replace suspect LRU. O-level support test equipment (as referenced in T.O.) are not used. I-level T.O. does not contain enough detail, so use is made of depot T.O. to provide job insight. CND/UR experiences are largely due to aircrew inexperience.

I-LEVEL OBSERVATIONS

I-level operates suspect LRU on hot mock-up to verify failures. Discrepant LRU is routed to depot. Fault isolation is occasionally to SRU level. Discrepant SRUs are routed to depot. The modular design of system, with most of the electronics in one LRU, aids in the maintenance process.

RECORDS AND FORMS USED

AFTO Form 781, AFTO Form 349 and SAC Form 126 are completed at debriefing and copies sent to Job Control, AMS Squadron and Production Analysis. AFTO Form 349 maintained at I-level shop, copies sent to AMS Analysis for entry on AFTO Form 95 A/C Historical files by A/C tail numbers.

COMMENTS

O-level does not file 799-H actions (CND), and I-level radio shop does not file 799-B actions (UR). Flight Analysis group files AFTO Form 349 "799-B" actions, but only by aircraft tail number.

FIELD SURVEY REPORT EXCERPTS

A19 **DATE:** 12-4-79 CAUSE NO. 4

AFB: A	**AIRCRAFT:** B-52D	**AN/DESIGNATOR:** ARN-118/TACAN

DEBRIEFING OBSERVATIONS

Formal debriefing takes place within 30 minutes of A/C recovery. The aircrew completes the AFTO Form 781 prior to debriefing. A checklist is followed for debriefing procedure. Checklist is SAC Form 77. Debriefing maintains history by aircraft number on SAC Form 126. Repeat discrepancies are checked at each debriefing.

O-LEVEL OBSERVATIONS

O-level maintenance personnel dispatched from the I-level shop. The same personnel perform both O-level and I-level maintenance tasks. O-level maintenance consists of fault isolation to LRU, removal and replacement of LRU, and repair of wiring, coax cables, etc. System provided with BIT, operable from the cockpit; Go/No Go system check. <u>The size and weight of test equipment is not conducive for use in all malfunction actions</u>. Feedback from I-level is very good.

I-LEVEL OBSERVATIONS

I-level bench check is made on suspect LRUs to determine serviceability, then LRU is either returned to supply/aircraft or forwarded to contractor depot for repair under RIW contract. Depot tests suspect LRU on hot mock-up prior to cleaning or repair. Bench check completed with test on hot mock-up. SAC Form 126 is maintained in I-level for history of each last five sorties of each A/C. AFTO Form 350 completed for LRUs in I-level.

RECORDS AND FORMS USED

AFTO Form 349 and SAC Form 126 are initiated for each squawk, at debriefing (who also assign Job Control Numbers). Copies are forwarded to Plans and Scheduling and Job Control. Discrepancies are dispatched by Job Control to the respective maintenance shops on AFTO Form 349. Aircraft history is maintained by the AMS Analysis section on AFTO Form 95 (one year) filed by A/C number.

COMMENTS

The Communication Shop discards I-level AFTO Form 349s that are coded "799-B," after data are inputted to MDC system.

FIELD SURVEY REPORT EXCERPTS

B28 **DATE:** 2-4-80 CAUSE NO. 6

AFB: B	**AIRCRAFT:** A-10A	**AN/DESIGNATOR:** ARC-164/UHF Radio

DEBRIEFING OBSERVATIONS

Debriefing accomplished immediately after A/C recovery. Pilot normally debriefs specialist prior to attending formal debrief. Formal debriefing is mainly a paper work function. Pilot and debriefer completes necessary forms and clarifies discrepancies. Repeat/recurring failures are identified and A/C history is maintained on TAC Form 93 (checked during each debriefing).

O-LEVEL OBSERVATIONS

Verification of pilot squawk, and troubleshooting/fault isolation to the LRU level. Suspect LRUs are removed and bench checked in the I-level shop. Replacements are routed from supply or returned from I-level. Troubleshooting by substitution: removal of suspect LRU to I-level bench check. Flight line test equipment are not used.

I-LEVEL OBSERVATIONS

Maintenance instructions are to isolate a fault to a SRU. Fault isolation consists of hot mock-up performance test and trouble analysis. The trouble analysis procedures are given in the form of logic flow charts. After a fault has been isolated, repair instructions are provided. Removed SRUs are NRTS to depot.

RECORDS AND FORMS USED

AFTO Form 349 is originated at debriefing and copies sent to the Job Control and AMUs. TAC Form 122, TAC Form 93 and local forms are completed and filed. Copies are forwarded to the Plans and Scheduling and Analysis. I-level files AFTO Form 349 for 90 days.

COMMENTS

The modularity of the system, with all the electronics in one LRU, aids the maintenance process.

FIELD SURVEY REPORT EXCERPTS

B15 **DATE:** 2-4-80 CAUSE NOS. 4,8

AFB: B	AIRCRAFT: A-10A	AN/DESIGNATOR: ARN-118/TACAN

DEBRIEFING OBSERVATIONS

Debriefing conducted when pilot comes to debriefing, after flight. Debriefer calls on maintenance specialist only when required. Pilot and debriefer complete required forms and clarify discrepancies. The pilots often debrief the maintenance specialist at the A/C, prior to the formal debriefing. Formal debriefing is a "paper work function." Repeat/recurring failures are identified (TAC Form 93) and checked during each debriefing.

O-LEVEL OBSERVATIONS

There is no organizational level AGE available. Two local TACAN test stations are used for operational check. Suspect LRUs are removed and sent to CRS shop for bench check and repair. Normally, LRUs are cannibalized from other A/C to repair the A/C system. The O-level maintenance specialist is considered merely a "black box changer." There is very little feedback from I-level to O-level.

I-LEVEL OBSERVATIONS

Performs operational check of suspect LRUs. LRUs are under warranty (RIW) and therefore must be NRTS to contractor's depot for repair. I-level uses test set and hot mock-up. There is very little feedback from depot to I-level. Depot sends reports to WR-ALC.

RECORDS AND FORMS USED

AFTO Form 349 is generated at debriefing and copies are forwarded to Job Control and appropriate AMUs. TAC Form 122, TAC Form 93 and other forms are completed, and copies are forwarded to Plans and Scheduling and Analysis. The AMU initiates an AFTO Form 349 from the A/C AFTO Form 781: a 90-day history is maintained by A/C tail numbers. CRS' 90-day file is by WUC.

COMMENTS

Same test procedures used by I-level maintenance shops are used at contractor's depot (per the terms of the RIW contract).

FIELD SURVEY REPORT EXCERPTS

C17 **DATE:** 3-10-80 CAUSE NOS. 1,6

AFB: C	**AIRCRAFT:** F-15A	**AN/DESIGNATOR:** ARN-118/TACAN

DEBRIEFING OBSERVATIONS

Debriefing is conducted after recovery of A/C. The pilots debrief crew chiefs at the A/C, but formal debriefing is in a building. Debriefer writes-up AFTO Form 349 for squawks. If debriefer feels that a maintenance specialist is needed at the debriefing, one is called to further interrogate the pilot. Repeat/recurring failures are identified on TAC Form 93.

O-LEVEL OBSERVATIONS

AMU responds to AFTO Form 349 created by debriefer: takes tool box and earphones, and functionally checks TACAN by exercising BIT. Suspect LRU is routed to I-level for bench check. Some test equipment is available from Centralized Test/Tool Repair, but is not used. Most missions are recovered as Class 1 (no squawks), because this AFB has new A/C. LRU is routed to I-level with AFTO Form 350 attached, at I-level an AFTO 349 is completed to document repair.

I-LEVEL OBSERVATIONS

Two manual test stations are used at this activity. At this activity, when the TACAN is removed by O-level, the R/T Mount and Data Converter are removed as one unit, to be sent to I-level for fault verification. When TACAN is NRTS to contractor depot, the Data Converter accompanies it. The same test procedures used by I-level are used by depot (required by RIW contract). History is maintained on AFTO 95 by LRU serial number and A/C tail number.

RECORDS AND FORMS USED

Aircrew squawks are included on AFTO Form 781, which is transcribed to AFTO Form 349 by debriefer, with copy telecopied to Job Control. Affected AMU specialist picks up copy of AFTO Form 349 for use in effecting repair or replacement of avionic equipment. If suspect LRU is sent to I-level it carries AFTO Form 350. Contractor RIW summaries are sent monthly to WR-ALC.

COMMENTS

Verification of suspect LRUs is in accordance with the terms of the RIW contract.

FIELD SURVEY REPORT EXCERPTS

C9 **DATE:** 3-10-80 CAUSE NO. 1

AFB: C	**AIRCRAFT:** F-15A	**AN/DESIGNATOR:** APX-101/IFF

DEBRIEFING OBSERVATIONS

Aircrew squawks are written by pilots: AFTO Form 781 is used for system malfunctions. Debriefing normally within 15 minutes of A/C recovery. Crew chief first debriefs pilot (maintenance specialist is frequently present). Aircrew squawks are often documented by use of AFTO Form 349 telewriter. Job Control numbers are assigned by "block" to the debriefing group. Repeat/recurring failures are identified on TAC Form 122.

O-LEVEL OBSERVATIONS

Fault isolation accomplished by remove/replace substitution of LRUs until squawk is resolved. Removed LRUs are routed to I-level for bench check. LRU is expedited by the Repair Control Monitor, who inducts the LRU, creates an AFTO Form 350 and routes to the appropriate "Due In For Maintenance" group. Maintenance Work Control Document AFLC Form 959 is the maintenance checklist. This AFB has recent A/C, therefore 60 percent of sorties are Code 1 (no squawks).

I-LEVEL OBSERVATIONS

Performance testing and fault isolation by manual test station. SRUs are plug-in type: easy I-level repair (or NRTS to depot). LRU fault isolation on test set to PCB level (at depot, LRUs are disassembled, cleaned and reassembled prior to testing — could contribute to high UR rate at depot level). Depot SRU fault verification by "substitution" in hot mock-up.

RECORDS AND FORMS USED

Incoming LRUs are received at I-level (manual) shop on AFTO Form 350 from the Repair Cycle Monitor. I-level creates AFTO Form 349 to input to Maintenance Analysis Section. I-level maintains history on AFTO Form 95, for all serialized SRUs. Appropriate AMU and maintenance specialist pick up their copies of AFTO Form 349 from debriefer and then routes suspect LRU to Asset Control.

COMMENTS

BIT circuits monitor critical parameters of transponder and provide output when a fault occurs.

FIELD SURVEY REPORT EXCERPTS

C5 **DATE:** 3-13-80 CAUSE NOS. 1,3

AFB: C	**AIRCRAFT:** F-15A	**AN/DESIGNATOR:** APG-63/PROCESSOR

DEBRIEFING OBSERVATIONS

Aircrew evaluation of system performance is documented on AFTO Form 781. System malfunctions are noted and elaborated during interview with crew chief. Debriefing immediately after A/C recovery. Status of malfunctions are annotated on AFTO Form 349.

O-LEVEL OBSERVATIONS

BIT test used by ground O-level specialist: many CNDs experienced. Maintenance specialist removes and replaces suspect LRUs to resolve A/C squawks. Suspect LRUs are NRTS to depot. Hughes representative, at this AFB, states that he believes that 60 percent of the CNDs are caused by test station software test voids (he has written three reports on this subject, to date).

I-LEVEL OBSERVATIONS

Data Processor requires 1.5 hours of automatic testing to verify malfunction. This LRU is received with AFTO Form 350 and I-level creates another AFTO Form 349 which is sent to the Flight Analysis group. Troubleshooting done by F-15 Automatic Test Station shop personnel. Some feedback on URs, from depot. T.O. 12P2-2APG63-38-1 is good but "slow": it would be helpful to be able to restart test program in the middle of this T.O. procedure.

RECORDS AND FORMS USED

History tracked on AFTO Form 95. Debriefing completes AFTO Form 349 on telecopier (copies to Job Control and the affected maintenance specialist). Debriefing maintains history file (by tail number) on TAC Form 93. Repeat and recurring failures are identified on TAC Form 122.

COMMENTS

This CRS has completed a "mobility demonstration" for the test station and were inoperative only three days.

FIELD SURVEY REPORT EXCERPTS

C33 | DATE: 3-10-80 | CAUSE NO. 7

AFB: C	AIRCRAFT: F-15A	AN/DESIGNATOR: ARC-164/UHF Radio

DEBRIEFING OBSERVATIONS

Debriefing accomplished after A/C recovery. Crew chief debriefs pilot at the A/C, but forms are completed during follow-on debriefing. Pilot completes AFTO Form 781 and squawks are annotated by debriefer on AFTO Form 349 (copy, via telecopier, is sent to Job Control). Debriefer calls in maintenance specialist, if required.

O-LEVEL OBSERVATIONS

O-level removes and replaces suspect LRUs. Removed LRU is sent to I-level for bench check. Replacements are from Supply or returned from I-level shop. Squawks are verified by troubleshooting, using the dual system installation in the A/C. Test equipment not utilized by the AMUs.

I-LEVEL OBSERVATIONS

Maintenance instructions are to isolate a fault to an SRU. Fault isolation consists of performance test and trouble analysis procedures. The trouble analysis procedures are given in the form of logic flow charts. After a fault has been isolated, repair instructions are provided. Repair instructions consist of removal and replacement instructions or adjustment procedures. Two manual test stations are in use at this AFB maintenance activity.

RECORDS AND FORMS USED

Repeat/recurring failures are identified on TAC Form 93, at debriefing activity. AFTO Form 349 completed as required by Pilot's completed AFTO Form 781. AMU specialist works on squawk reported in AFTO Form 349. If suspect LRU is to be removed and sent to I-level, AFTO Form 350 (tag) is completed for the routing. AFTO Form 95 is filed as A/C history, by A/C file number and LRU serial number.

COMMENTS

System design is modular, which permits easy replacement of SRUs at I-level.

FIELD SURVEY REPORT EXCERPTS

D20 **DATE:** 3-12-80 CAUSE NO. 1

AFB: D	**AIRCRAFT:** AC-130H	**AN/DESIGNATOR:** ARN-118/TACAN

DEBRIEFING OBSERVATIONS

Debriefing takes place within 15 minutes of A/C recovery (24 hour coverage). Debriefers complete AFTO Form 349, TAC Form 93, and TAC Form 122. Copy of AFTO Form 349 is sent to Job Control. Repeat/recurring failures are identified on TAC Form 93, which is kept in the individual A/C record by tail number. Debriefer will call in maintenance specialists, when necessary. Most missions are recovered as Code 1 (no squawks). Average sortie duration is five hours.

O-LEVEL OBSERVATIONS

Responds to AFTO Form 349, initiated by debriefer: takes tool box and earphones, and functionally checks TACAN by exercising BIT. Suspect LRU is routed to I-level bench check. Some test equipment, available from I-level, is not used due to its undependability. Other test equipment is used at the flightline for extensive troubleshooting by I-level personnel when a UR is found in the shop. The same personnel participate in O-level and I-level maintenance tasks (at A/C and in the shops). Troubleshooting is performed by substitution of LRUs to verify faults.

I-LEVEL OBSERVATIONS

Performs verification of suspect LRUs. However, in accordance with the RIW contract provisions LRUs are sent to contractor depot facilities for repair. I-level personnel are skilled and used also at O-level for troubleshooting (modified POMO concept). Contractor depot uses test equipment and hot mock-up for fault isolation. The same test procedures are used by I-level as used by depot as required by RIW contract.

RECORDS AND FORMS USED

Debriefers complete TAC Form 122, TAC Form 93 and AFTO Form 349. AFTO Form 781 is completed by pilot (basis for AFTO Form 349). If LRU malfunction is fixed, the AFTO Form is closed out. If LRU leaves the A/C, an AFTO Form 350 results, which is sent to the MDC Center for entry into the data system. The AFTO Form 350 is sent with the suspect LRU to Supply, if depot action is required.

COMMENTS

There are six MC-130E and ten AC-130H A/C at this site. Since they have the same TACANs, data are combined under the AC-130H designator.

FIELD SURVEY REPORT EXCERPTS

D2 **DATE:** 3-14-80 CAUSE NOS. 1,4,9

AFB: D	AIRCRAFT: AC-130H	AN/DESIGNATOR: ASN-90/INS

DEBRIEFING OBSERVATIONS

Debriefing takes place within 15 minutes of A/C recovery (24 hour coverage). Debriefers complete AFTO Form 349, TAC Form 93, and TAC Form 122. Copy of AFTO Form 349 is sent to Job Control. Repeat/recurring failures are identified on TAC Form 93, which is kept in the individual A/C record by tail number. Debriefer will call in maintenance specialists, when necessary. Most missions are recovered as Code 1 (no squawks). Average sortie duration is five hours.

O-LEVEL OBSERVATIONS

Fault isolation accomplished by black box "swapping." The Repair Cycle Monitor expedites LRUs to I-level shop, using AFTO Form 350. There is no support equipment to troubleshoot the INS. O-level maintenance checklist T.O. IC-130(A) H-2-14CL-1 is available. This A/C has a different INS configuration, as compared to that on the A-7D A/C. Here, the INS has an auxiliary battery pack.

I-LEVEL OBSERVATIONS

No test set per se, but LRU may be operated on ASN-90 computer hot mock-up in Fire Control shop. Faulty LRUs are NRTS to depot. I-level shop could use an INS test set, as specified in the T.O.s.

RECORDS AND FORMS USED

No LRU history maintained in I-level shop (they don't see many). AFTO Form 349 completed by debriefer who keeps a copy and send a copy to the Job Control section. Aircraft history maintained on AFTO Form 781 and TAC Form 93, by the debriefing group. Repeat/recurring failures are identified on TAC Form 122 and TAC Form 93.

COMMENTS

Accessibility problem involves IMU.

FIELD SURVEY REPORT EXCERPTS

D35 **DATE:** 3-10-80 CAUSE NO. 7

AFB: D	**AIRCRAFT:** AC-130H	**AN/DESIGNATOR:** ARC-164/UHF Radio

DEBRIEFING OBSERVATIONS

Formal debriefing accomplished within 15 minutes after A/C recovery. Debriefer completes AFTO Form 349, TAC Form 122 and TAC Form 93. Maintenance specialists are used, as required. Repeat/recurring failures are identified on TAC Form 93, which is filed by A/C tail number.

O-LEVEL OBSERVATIONS

The CRS/AMU responds to AFTO Form 349 originated by debriefer. They take tool box and earphones, and functionally test the system. Since dual systems are used in the A/C, suspect LRUs are swapped, to aid in troubleshooting. If LRU is considered faulty, it is routed to I-level.

I-LEVEL OBSERVATIONS

Functional test is performed on suspect LRU, on hot mock-up. The LRU is troubleshot to faulty SRU, which is replaced. The discrepant SRU is routed to depot for repair. This AFB activity uses a modified POMO concept: personnel are identified as belonging to CRS and AMU, but they are assigned to the I-level shop. The person troubleshooting at O-level can be the same who will fault verify the suspect LRU at I-level.

RECORDS AND FORMS USED

Debriefing completes AFTO Form 349 after pilot completes AFTO Form 781. TAC Form 122 and TAC Form 93 are completed by debriefer. For this system, the same personnel investigating a squawk at the A/C will complete an AFTO Form 350 for LRU routed to I-level (where another AFTO Form 349 is originated). AFTO Form 349 is sent to Maintenance Control for entry into computer.

COMMENTS

The AC-130H is a modified basic C-130 A/C. At this AFB, ten AC-130H and six MC-130E A/C are in use. All are designated as AC-130H, herein.

FIELD SURVEY REPORT EXCERPTS

E1 **DATE:** 3-5-80 CAUSE NOS. 2,4,9

AFB: E	**AIRCRAFT:** A-7D	**AN/DESIGNATOR:** ASN-90/INS

DEBRIEFING OBSERVATIONS

Aircrew evaluates A/C performance on AFTO Form 781. Malfunctions are identified during debriefing session immediately after A/C recovery. Approximately 35 percent of sorties are Code 1 (no squawks).

O-LEVEL OBSERVATIONS

LRU swapping fixes most squawks. T.O. checklists and test equipment are not considered as useful, therefore "short cuts" are prevalent: troubleshooting by substitution (i.e., IMU and Power Supply Adapter are often both sent to I-level shop to determine which one has a malfunction).

I-LEVEL OBSERVATIONS

Work load on INS comes from on-aircraft squawks and the functional check of all units received from depot: depot set-up of unit is done at a different specification level. The functional verification and fault isolation tasks are performed on 15-year old tape-controlled, 3-bay, automatic test set. Fault isolation is to SRU level, and SRUs are NRTS to depot. Due to lack of commonality of test equipment at depot and I-level, all IMUs from depot are retested.

RECORDS AND FORMS USED

AFTO Form 349 goes to affected maintenance specialist and to Job Control. Aircraft history is maintained by tail number on AFTO Form 95. I-level does not maintain AFTO Form 349, but does keep AFTO Form 95 for history record file. I-level inputs to the Flight Analysis via AFTO Form 349. Repeat/recurring failures are identified.

COMMENTS

Accessibility problems involve Power Supply Adapter and IMU.

FIELD SURVEY REPORT EXCERPTS

E27 **DATE:** 3-4-80 CAUSE NO. 6

AFB: E	AIRCRAFT: A-7D	AN/DESIGNATOR: ARC-164/UHF Radio

DEBRIEFING OBSERVATIONS

Debriefing accomplished as soon as possible after landing. Pilot completes AFTO Form 781 prior to debriefing. If pilot's squawks are not within the debriefer's speciality, he will call in a maintenance specialist. Debriefer writes-up an AFTO Form 349 for each squawk and submits copy to maintenance specialist and to Job Control group. Aircraft history (tail number) is maintained on TAC Form 95.

O-LEVEL OBSERVATIONS

O-level removes and replaces suspect LRUs. Removed LRUs are routed to I-level bench check. Functional test may be made by attempting to "call" the test station located in the I-level shop. Flightline test equipment is not used.

I-LEVEL OBSERVATIONS

Maintenance instructions are to isolate a fault to an SRU. Fault isolation consists of hot mock-up performance test and trouble analysis procedures. The trouble analysis procedures are in the form of logic flow charts. After a fault has been isolated, repair instructions are provided. Removed SRUs are NRTS to depot.

RECORDS AND FORMS USED

AFTO Form 781 completed by pilot. AFTO Form 349 completed for each malfunction or discrepancy. LRUs received from Repairable Components Maintenance (RCM) carry AFTO Form 350. Thereafter, LRU is logged and an AFTO Form 349 originated: I-level shop history file (3 months) indicate few 799-B actions.

COMMENTS

Feedback from depot to I-level only occurs when a MDR is submitted from I-level maintenance.

FIELD SURVEY REPORT EXCERPTS

E13 **DATE:** 3-4-80 CAUSE NOS. 1,6

AFB: E	**AIRCRAFT:** A-7D	**AN/DESIGNATOR:** ARN-118/TACAN

DEBRIEFING OBSERVATIONS

Debriefing is conducted as soon as possible after landing. The pilot completes an AFTO Form 781. If there are any discrepancies or malfunctions of the A/C, they are noted on the 781. The debriefer will call in a specialist for particular systems, when necessary.

O-LEVEL OBSERVATIONS

A confidence test of the system provides the operator with information to ensure that system is operating correctly. If signal becomes unreliable or is lost, an automatic self-test occurs to check the system. O-level responds to AFTO Form 349 (created at debriefing): suspect LRU is functionally checked by exercising BIT. Suspect LRU is routed to I-level for bench check. Test set is available from centralized test/tool repair section, but is not utilized. T.O.s are not used at the A/C. Troubleshooting is done by substituting a good unit for a suspect unit.

I-LEVEL OBSERVATIONS

Verifies defects on suspect LRUs. Since LRU is under warranty (RIW), suspect LRUs are NRTS to contractor's depot for repair. At depot, LRU is tested prior to any repair or cleaning: each LRU is tested on a hot mock-up. LRUs are received at I-level accompanied by an AFTO Form 350 (tag): from the tag an I-level AFTO Form 349 is generated.

RECORDS AND FORMS USED

The pilot fills out an AFTO Form 781. Squawks are written on AFTO Form 349 for submittal to the maintenance specialist, a copy is given to Job Control. Aircraft history (by tail number and LRU serial number) is maintained on AFTO Form 95.

COMMENTS

Contractor depot tests are accomplished in the presence of DCASMA.

FIELD SURVEY REPORT EXCERPTS

F10 **DATE:** 2-19-80 CAUSE NO. 1

AFB: F	AIRCRAFT: F-15A	AN/DESIGNATOR: APX-101/IFF

DEBRIEFING OBSERVATIONS

Debriefing follows each flight. The aircrew evaluates the A/C, systems performance and documents discrepancies. Maintenance specialist is occasionally present. Repeat and recurring failures are identified: a "repeat" is the same squawk on back-to-back flights, a "recurring" discrepancy usually has one or two good flights (Code 1) between identical squawks.

O-LEVEL OBSERVATIONS

BIT circuits monitor critical operating parameters of the transponder and provide output when a fault occurs. O-level verifies aircrew squawks, fault isolates to LRU, and removes and replaces suspect LRU. Repairs wiring, connectors, etc. I-level uses a suitcase-type tester. T.O. 1-F15A-2-22 functional checklist is available.

I-LEVEL OBSERVATIONS

Bench checks and fault isolates suspect LRU on test station. Fault isolation is to SRU level: remove and replace SRU. Faulty SRU to depot-level for repair. I-level uses IFF test set and Manual Test Station. Maintenance Work Control Document AFLC Form 959 is the maintenance checklist. Depot allows disassembly, cleaning and reassembly of suspect LRU prior to test.

RECORDS AND FORMS USED

Debriefer fills out TAC Form 93 and, if any discrepancies, AFTO Form 349 which is routed to Job Control via telecopier and another copy to the affected AMU via an expeditor.

COMMENTS

Depot level fault verification of SRUs is accomplished by substitution of the SRU in a hot mock-up.

FIELD SURVEY REPORT EXCERPTS

F4 **DATE:** 2-19-80 CAUSE NOS. 1,5,6

AFB: F	**AIRCRAFT:** F-15A	**AN/DESIGNATOR:** APG-63/PROCESSOR

DEBRIEFING OBSERVATIONS

Aircrew documents A/C system performance after each sortie: all malfunctions are annotated. Debriefing accomplished immediately after A/C recovery.

O-LEVEL OBSERVATIONS

Removes and replaces suspect LRU. Originates AFTO Form 350 and routes suspect LRU to I-level bench check. Experience many CNDs after BIT test by O-level maintenance specialist. Checks for set BIT flags and latches (post-flight). O-level attempts to repeat discrepancy by BIT operation. Many CNDs for on-aircraft equipment.

I-LEVEL OBSERVATIONS

Squawked LRU comes through a control point called "Due in for Maintenance" (DIFM). LRU travels on AFTO Form 350, which can be initialized from the Repairable Aircraft Asset Center (RAAC) or Supply. LRU automatically fault isolated to SRU. DIFM Central Control maintains LRU history (AFTO Form 95). Troubleshooting done by F-15 Automatic Test Station shop personnel. Use of experimental environmental test chamber has not been successful, to date.

RECORDS AND FORMS USED

Debriefer completes AFTO Form 781, AFTO Form 349, and TAC Form 93 (and other appropriate forms): one copy is routed (via telecopier) to Job Control and another copy is delivered to affected AMU via expeditor.

COMMENTS

I-level shop supervision feels that URs are due to learning a new system.

FIELD SURVEY REPORT EXCERPTS

F32 **DATE:** 2-18-80 CAUSE NO. 7

AFB: F	**AIRCRAFT:** F-15A	**AN/DESIGNATOR:** ARC-164/UHF Radio

DEBRIEFING OBSERVATIONS

Pilot completes AFTO Form 781 used at debriefing. Squawks are each written on a separate AFTO Form 349 by debriefer. A maintenance specialist is called to debriefing, when required. Pilot identifies any repeat/recurring failures.

O-LEVEL OBSERVATIONS

O-level maintenance consists of swapping ARC-164 systems from one position to another (dual systems are in A/C) to fault isolate to faulty LRU. Test equipment not used at this AFB activity.

I-LEVEL OBSERVATIONS

LRU routed to I-level by DIFM (see "Records", below). I-level troubleshoots to the SRU level: completes verification of fault and replacement of faulty LRU/SRU. SRU repair accomplished at depot level maintenance after test using hot mock-up. Depot disassembles, cleans and reassembles suspect LRUs prior to test.

RECORDS AND FORMS USED

Debriefing completes AFTO Form 781H, TAC Form 93 and AFTO Form 349. AFTO Form 350 (tag) with suspect LRU is received at I-level by the Due-In-For-Maintenance (DIFM) group, who then completes AFTO Form 349.

COMMENTS

Having a dual ARC-164 system makes maintenance easy since each system can be swapped to isolate faulty LRU. The dual system almost eliminates the CND/UR classifications.

FIELD SURVEY REPORT EXCERPTS

F16 **DATE:** 2-20-80 CAUSE NO. 1

AFB: F	**AIRCRAFT:** F-15A	**AN/DESIGNATOR:** ARN-118/TACAN

DEBRIEFING OBSERVATIONS

Debriefing accomplished immediately after A/C recovery. TAC Form 93 completed by debriefer. The pilot completes AFTO Form 781 for maintenance debriefing specialist. AFTO Form 349 is completed if there are any squawks. The pilot describes any malfunctions to the debriefer, who will call in a maintenance specialist if there are unusual problems. Repeat and recurring squawks are identified by the pilot to the debriefer.

O-LEVEL OBSERVATIONS

Maintenance at O-level consists of BIT test. If BIT indicates faulty unit, and a check of cables and/or reseating does not correct the discrepancy, the LRU is removed and a request is made to the Supply group for a replacement.

I-LEVEL OBSERVATIONS

I-level only does fault verification on test set. If LRU is determined to be faulty, it is NRTS to contractor's depot for repair. LRUs are under warranty (RIW). Depot uses test set and hot mock-up. LRUs are inducted into I-level with an AFTO Form 350 (tag) by the DIFM group, who generates an AFTO 349 for the I-level shop. Depot tests suspect LRU before any cleaning or repairing.

RECORDS AND FORMS USED

AFTO Form 349 is generated for squawks: copies are transmitted via telecopier to the Maintenance Production Control group and a copy is delivered to the cognizant AMU. Daily, weekly, monthly and special reports can be obtained from the Data Analysis Group.

COMMENTS

The LRU received from supply also includes the mounting rack.

FIELD SURVEY REPORT EXCERPTS

F38 **DATE:** 2-8-80 CAUSE NO. 6

AFB: F	**AIRCRAFT:** T-38	**AN/DESIGNATOR:** ARC-164/UHF Radio

DEBRIEFING OBSERVATIONS

Debriefing accomplished immediately following A/C recovery. Pilot completes AFTO Form 781. An AFTO Form 349 is completed by debriefer for any reported malfunction. Debriefer will call in a maintenance specialist, if necessary. Repeat/recurring failures are identified.

O-LEVEL OBSERVATIONS

Suspect LRUs are normally removed and replaced when a malfunction is written-up. If A/C wiring/cables are suspect, a voltmeter and wattmeter may be used. O-level troubleshooting consists of functional check-out and swapping of suspect LRU: to "clear" any AFTO Form 349 documents. System is modular, with majority of the electronics contained in one LRU.

I-LEVEL OBSERVATIONS

I-level shop troubleshoots to SRU level. Suspect SRUs are removed and replaced. No bit/piece repair is authorized at I-level. LRUs are adjusted and aligned. Depot level maintenance is to the piece-part level. Suspect LRUs are received with AFTO Form 350 (tag) attached.

RECORDS AND FORMS USED

Using the pilot's AFTO Form 781, required TAC Form 93 and AFTO Form 349 documents are initiated, with all necessary information as to type of malfunction, when discovered, and a Job Control Number (JCN) assigned. I-level initiates an AFTO Form 349 from any AFTO Form 350 received from O-level. Copies to Analysis group.

COMMENTS

Weapon system mission is to provide tactical training for student pilots transitioning from T-38 to F-15 A/C.

FIELD SURVEY REPORT EXCERPTS

F23 **DATE:** 2-18-80 CAUSE NOS. 1,4

AFB: F	**AIRCRAFT:** T-38	**AN/DESIGNATOR:** ARN-118/TACAN

DEBRIEFING OBSERVATIONS

Debriefing accomplished after A/C recovery. Pilot completes AFTO Form 781. AFTO Form 349 is completed, if necessary, and copy is expedited to Job Control group who routes copy to the appropriate CRS. Maintenance specialist is called into debriefing as required. Repeat/recurring failures are identified.

O-LEVEL OBSERVATIONS

BIT can be exercised by aircrew or O-level maintenance personnel. Available test equipment is unwieldy and therefore is not often used. Troubleshooting by operational check and BIT: LRUs indicating "No Go" are removed and routed to CRS.

I-LEVEL OBSERVATIONS

Performance check on hot mock-up. LRUs under RIW contract, therefore faulty LRUs are routed to contractor's depot for repair. The same test procedures used in I-level are used at contractor's depot for repair, as required by RIW contract. Depot tests LRUs on a hot mock-up.

RECORDS AND FORMS USED

Using the pilot's AFTO Form 781, required TAC Form 93 and AFTO Form 349 documents are initiated, with all necessary information as to type of malfunction, when discovered, and a Job Control Number (JCN) assigned. I-level initiates an AFTO Form 349 from any AFTO Form 350 received from O-level. Copies to Analysis group.

COMMENTS

Weapon system mission is to provide tactical training for student pilots transitioning from T-38 to F-15 A/C.

FIELD SURVEY REPORT EXCERPTS

G7 **DATE:** 11-13-79 CAUSE NOS. 1,4,5

AFB: G	**AIRCRAFT:** F-15A	**AN/DESIGNATOR:** APX-101/IFF

DEBRIEFING OBSERVATIONS

Debriefing follows within 15 to 20 minutes of each flight. Pilot sits in a booth that is a F-15 cockpit mock-up. Debriefing allows pilot the opportunity of evaluating performance of the A/C systems during flight and assists in documenting discrepancies. Repeat/recurring failures are documented on TAC Form 122, but the IFF is seldom a repeat write-up.

O-LEVEL OBSERVATIONS

Performs verification of aircrew squawks, fault isolates to LRU, removes and replaces suspect LRUs, repairs wiring/coax cables, etc. Uses BIT (IFF suitcase tester AGS 349 seldom used because it is heavy: 40 pounds). O-level repair accomplished with very little feedback from I-level (separate groups). Maintenance Work Control Document AFLC Form 959 is the maintenance checklist. One maintenance specialist's opinion is that some CNDs/URs are the result of both BIT use (instead of ATE) and lack of sufficient technical ability of maintenance personnel.

I-LEVEL OBSERVATIONS

Performs LRU testing and fault isolation to SRU level using test station. SRUs are NRTS to depot for repair. Handling of scope and test equipment only per Technical Order directions. Suspect LRUs received at CRS with AFTO Form 350. LRU is tested, the How Malfunctioned code determined, and AFTO Form 349 filled out prior to routing the LRU to supply or depot. Depot disassembles, cleans and reassembles suspect LRUs prior to test.

RECORDS AND FORMS USED

TAC Form 93 and AFTO Form 349 are completed by debriefer. Malfunction information on AFTO Form 349 is sent to Job Control via telewriter. Job Control notes each discrepancy on AFTO Form 349 and notifies appropriate maintenance section. Other forms completed are AFTO Form 350, AFTO Form 781H and TAC Form 93.

COMMENTS

Depot SRU fault verification is accomplished in a Hot Mock-up, which is considered better than the Automatic Test Station (ATS).

FIELD SURVEY REPORT EXCERPTS

G6 **DATE:** 11-12-79 CAUSE NOS. 1,3,6

AFB: G	**AIRCRAFT:** F-15A	**AN/DESIGNATOR:** APG-63/PROCESSOR

DEBRIEFING OBSERVATIONS

Debriefing accomplished within 10 to 20 minutes after touchdown. Pilot sits in a booth that is a F-15 cockpit mock-up. Malfunction information is sent to Job Control via telewriter. Debriefing allows pilot the opportunity of reviewing performance of the A/C systems during flight and assists in documenting discrepancies. Repeat/recurring failures (or aborts/incidents) are documented on TAC Form 122.

O-LEVEL OBSERVATIONS

Fault isolation to LRU level using BIT — then O-level personnel remove and replace faulty (indicated) LRUs. O-level technician will have changed every LRU within his first six months of service, which seems to limit his motivation (may remove an LRU just to "sign-off" a squawk). A great deal of on-the-job training exists at this AFB. When an LRU is "pulled" at O-level, the LRU goes across the AIS at I-level, where something may be "adjusted."

I-LEVEL OBSERVATIONS

Fault isolate LRU to SRU level using AIS. Faulty SRU is NRTS to depot. Operational checkout of radar set (APG-63) is verified by using a weapon system integrated BIT. No hand probing. T.O.s lack configuration control (e.g., AF vs. MCAIR vs. Bendix vs. Hughes, etc.). AFTO Form 349s are sent monthly to WR-ALC. AIS has low repeat failure squawks (5 percent), and low backlog of LRUs wating for test. Some feedback from depot.

RECORDS AND FORMS USED

TAC Form 93 and AFTO Form 349 are completed by debriefer. Job Control notes each discrepancy on AFTO Form 349 and notifies appropriate maintenance section. Other forms completed are AFTO Form 781H (pilot squawk sheet) and AFTO Form 350. CRS receives suspect LRU with AFTO Form 350 — after test LRU gets an AFTO Form 349 containing How Malfunctioned code data, prior to routing LRU to supply or depot.

COMMENTS

I-level shop chief states that one AIS tracks when other one works, and AIS cannot duplicate O-level BIT tests due to specification variations.

FIELD SURVEY REPORT EXCERPTS

H18 **DATE:** 1-8-80 CAUSE NO. 6

AFB: H	AIRCRAFT: F-111E	AN/DESIGNATOR: ARN-118/TACAN

DEBRIEFING OBSERVATIONS

Debriefing is conducted after recovery of A/C. Debriefer interviews pilot and notes squawks on AFTO Form 349.

O-LEVEL OBSERVATIONS

O-level practice is substitution of suspect LRUs. O-level replaces LRUs, reseats connectors, replaces cables and connectors, as well as tightens them. Data gathered from shop records because there are no Base Level Inquiry System (BLIS) reports available.

I-LEVEL OBSERVATIONS

I-level does functional test only, using a locally fabricated console with the test equipment integrated into the console rather than distributed across the work bench. Fault verification is accomplished on hot mock-up. (Hot mock-up mounted in a low-bay console on wheels.) Faulty units routed to contractor depot level repair (RIW contract). Same test procedures used by depot for repair as I-level uses to test TACAN (required by contract).

RECORDS AND FORMS USED

AFTO Form 349 is initiated for each squawk. This AFB does not have an Analysis section and there are no "follow-on" reports. Local records are maintained. O-level maintains history records on AFTO Form 95.

COMMENTS

Due to few sorties, maintenance personnel are aware of repeat/recurring squawks.

FIELD SURVEY REPORT EXCERPTS

H12 **DATE:** 1-8-80 CAUSE NO. -

AFB: H	**AIRCRAFT:** F-111E	**AN/DESIGNATOR:** APN-167/ALTIMETER

DEBRIEFING OBSERVATIONS

Debriefing immediately after A/C recovery. Maintenance specialist interviews aircrew and writes squawks on AFTO Form 349. Repeat/recurring failures are known immediately (there are only six A/C assigned to this AFB).

O-LEVEL OBSERVATIONS

Press-to-test light indicates system is operative. System can be verified on ground or airborne. O-level maintenance consists of substitution of LRUs at the flightline.

I-LEVEL OBSERVATIONS

AFB does not have I-level shop per se. Suspect LRUs are bench checked at the depot, which is co-located with operational unit at this AFB. Adjustments and alignments are made at I-level as required, but any repairs are accomplished by routing the suspect LRU to the depot. (LRUs are partially disassembled, inspected, cleaned and reassembled prior to functional analysis on manual test set in hot mock-up at depot.) I-level uses LARA test set.

RECORDS AND FORMS USED

AFTO Form 349 is routed to Job Control. Job Control assigns job control numbers and routes to appropriate maintenance areas. AFTO Form 349 is created at O-level and travels to I-level shop which inputs maintenance action to MDC system data base. However, since user organization does not have a Flight Analysis Section, it is not obvious how Wing inputs to data base.

COMMENTS

Maintenance specialist debriefer conducts interview which helps isolate in-flight squawks, by elaboration of malfunction description.

FIELD SURVEY REPORT EXCERPTS

H26 **DATE:** 1-8-80 CAUSE NO. 6

AFB: H	**AIRCRAFT:** F-111E	**AN/DESIGNATOR:** ARC-164/UHF Radio

DEBRIEFING OBSERVATIONS

Debriefing accomplished after each flight. Pilot and maintenance supervisor informally discuss any avionic malfunctions or discrepancies. There are so few A/C and sorties that maintenance personnel are aware of all repeat/recurring failures. AFTO Form 349 is completed for each discrepancy.

O-LEVEL OBSERVATIONS

Troubleshooting is by substitution of suspect LRUs. There is a potential problem: the F-111F A/C uses a channel select indicator panel illuminated by 5-volt lamps, but the F-111E A/C panel uses 28-volt lamps. Since the panels are otherwise identical, a mixup during maintenance can short the illumination circuits.

I-LEVEL OBSERVATIONS

I-level maintenance is performed by the host activity on a "tenant agreement." Hot mock-up permits fault isolation to LRU. LRU fault isolation is accomplished by "hand probing." I-level shop has installed their hot mock-up in a cabinet on wheels. SRU repair is accomplished at depot-level maintenance. A few LRUs are received by depot for repair. Depot uses hot mock-up. At depot, suspect LRUs are disassembled, cleaned and reassembled prior to test.

RECORDS AND FORMS USED

AFB maintains historical records in file of AFTO Form 95. AFTO Form 349 completed for each malfunction or discrepancy.

COMMENTS

This AFB activity does not have an Analysis Section, and there are no follow-on reports.

FIELD SURVEY REPORT EXCERPTS

I8 **DATE:** 1-14-80 CAUSE NOS. 1,6

AFB: I	**AIRCRAFT:** F-15A	**AN/DESIGNATOR:** APX-101/IFF

DEBRIEFING OBSERVATIONS

Debriefing immediately after A/C recovery. Aircrew and debriefer informally complete forms necessary to facilitate maintenance. Repeat/recurring failures are identified and documented on TAC Form 122.

O-LEVEL OBSERVATIONS

BIT circuits monitor critical parameter of the transponder and provide output when a fault occurs (aircraft test and monitoring equipment). O-level substitutes suspect LRUs until the squawk is solved. Suspect LRUs are routed to I-level via the Repair Cycle Monitor. Maintenance Work Control Document AFLC Form 959 is the maintenance checklist.

I-LEVEL OBSERVATIONS

Uses hot mock-up with test sets, known good item and tester dummy load. Unit repaired in the ATS shop and in the Comm/Nav shop (ATS uses manual test station and Comm/Nav uses a hot mock-up). ATS shop repairs only those units from the F-15A aircraft. Malfunctioning SRUs are NRTS to depot for repair. AFTO Form 349 is filed at I-level for 90 days (by nomenclature and tail number).

RECORDS AND FORMS USED

Debriefing creates the AFTO Form 349 which information is phoned to the Job Control group. Job Control collects the forms every two hours. Copies of the forms are given to the Planning and Scheduling Section and also forwarded to Analysis.

COMMENTS

Depot SRU fault verification is accomplished in a hot mock-up, which is considered better than the automatic test station.

FIELD SURVEY REPORT EXCERPTS

I3 **DATE:** 1-14-80 CAUSE NO. 1

AFB: I	**AIRCRAFT:** F-15A	**AN/DESIGNATOR:** APG 63/PROCESSOR

DEBRIEFING OBSERVATIONS

Debriefing accomplished immediately after A/C recovery. Debriefer annotates as he informally interviews the aircrew. Difficult technical areas require additional support from the affected maintenance specialist.

O-LEVEL OBSERVATIONS

Routes suspect LRU to I-level and installs new LRU from supply (if available) or cannibalizes another A/C, or waits for I-level check/repair of suspect LRU. O-level attempts to repeat any reported discrepancy by ground operation of BIT, after taking account of set latches. There is some feedback from I-level to O-level regarding URs.

I-LEVEL OBSERVATIONS

Creates AFTO Form 349 and AFTO Form 95, and then sets up and checks LRU. Any replaced SRUs are NRTS to depot. All backlog parts are maintained in the shop and scheduled into work by the shop supervisor. I-level maintenance depends on F-15 Automatic Test Station shop personnel. There is some feedback from depot I-level regarding RTOKs.

RECORDS AND FORMS USED

AFTO Form 349 initiated during debriefing session. Repeat/recurring failures are identified and documented on TAC Form 122. AFTO Form 95 (by WUC and A/C tail number) are kept at I-level for history record files.

COMMENTS

Many CNDs and URs, but repeat write-ups receive special attention.

FIELD SURVEY REPORT EXCERPTS

129 **DATE:** 1-15-80 CAUSE NO. 6

AFB: I	**AIRCRAFT:** A-10A	**AN/DESIGNATOR:** ARC-164/UHF Radio

DEBRIEFING OBSERVATIONS

Debriefing accomplished immediately after A/C recovery. Pilot and debriefer complete necessary forms and clarify discrepancies. They are assisted by a maintenance specialist, when req 'red. Repeat/recurring failures are identified by debriefer.

O-LEVEL OBSERVATIONS

Remove and replace suspect LRUs. Removed LRUs are bench checked in the I-level shop. Replacement are from Supply or returned from the I-level shop. Troubleshooting is by substitution and removed LRU routed to I-level. Flightline test equipment is not used.

I-LEVEL OBSERVATIONS

Maintenance instructions are to isolate a fault to an SRU. Fault isolation consists of performing a hot mock-up performance test and trouble analysis. The trouble analysis procedures are given in the form of logic flow charts. After a fault has been isolated, repair instructions are provided. Removed SRUs are NRTS to depot. AFTO Form 95 is completed for each LRU and filed by WUC and LRU serial number (one year) as historical data.

RECORDS AND FORMS USED

AFTO Form 349 is originated by debriefer and copies sent to the Job Control and expeditor. Expeditor gives copy to Maintenance Section. Other forms are forwarded to Plans and Scheduling and to the Analysis Section. O-level AFTO Form 349 filed by A/C for 90 days. I-level AFTO Form 349 filed by system and part number (90 days).

COMMENTS

Test equipment and hot mock-up for LRU testing is offered by depot to support users who do not have field test equipment.

FIELD SURVEY REPORT EXCERPTS

I14 **DATE:** 1-15-80 CAUSE NO. 1

AFB: I	**AIRCRAFT:** A-10A	**AN/DESIGNATOR:** ARN-118/TACAN

DEBRIEFING OBSERVATIONS

Debriefing accomplished immediately after A/C recovery. Debriefer and pilot complete forms and clarify discrepancies. Debriefer is assisted by maintenance specialist when necessary. Repeat and recurring failures are identified by debriefer.

O-LEVEL OBSERVATIONS

A confidence test of the system provides the operator with information to ensure that the system is operating correctly. If signal becomes unreliable or is lost, an automatic self-test occurs to check the system. O-level responds to AFTO Form 349 created by debriefing group: takes tool box and earphones, and functionally checks suspect LRU by exercising BIT. Suspect LRU is routed to I-level for bench check. Most missions at this AFB are recovered as Class 1 (no squawks).

I-LEVEL OBSERVATIONS

Verifies suspect LRU as defective. LRU is under warranty (RIW) and therefore must be NRTS to contractor's depot for repair. LRUs are tested on a hot mock-up. Same test procedures used by I-level as used at contractor's depot (per contract).

RECORDS AND FORMS USED

AFTO Form 349 is forwarded to Job Control by debriefer. Copies of AFTO Form 349 are forwarded to the expeditor who transmits to maintenance section. Other forms are forwarded to Plans and Scheduling and to the Analysis Section.

COMMENTS

Contractor's depot tests suspect LRUs prior to any cleaning or repair.

FIELD SURVEY REPORT EXCERPTS

I31 **DATE:** 1-14-80 CAUSE NO. 6

AFB: I	**AIRCRAFT:** F-5E	**AN/DESIGNATOR:** ARC-164/UHF Radio

DEBRIEFING OBSERVATIONS

Debriefing is accomplished immediately after landing. Debriefer and pilot complete forms and classify documents, following debriefing guides, forms and procedures. Debriefer calls on maintenance specialist, when required.

O-LEVEL OBSERVATIONS

O-level removes and replaces suspect LRUs. LRUs are routed to I-level bench check. Replacements are from Supply or returned from the I-level shop. Troubleshooting is done by substitution of LRUs. Flightline test equipment is not utilized. O-level files AFTO Form 349 for 90 days; filed by A/C number. There is some feedback from I-level to O-level on UR actions (also true of depot feedback to I-level).

I-LEVEL OBSERVATIONS

Maintenance instructions are to isolate a fault to an SRU. Fault isolation consists of hot mock-up performance test and trouble analysis procedures. The trouble analysis procedures are given in the form of logic flow charts. After a fault has been isolated, repair instructions are provided. Repair instructions consist of removal and replacement instructions or adjustment procedures. Depot repair is to SRU level.

RECORDS AND FORMS USED

AFTO Form 349 is forwarded to Job Control with copy to expeditor for delivery to Maintenance. Other forms are forwarded to Plans and Scheduling and to Analysis. AFTO Form 95 (Historical Data) is completed for each suspect LRU, filed by WUC and LRU serial number (one year).

COMMENTS

The RT-1168 and RT-1145 LRUs are basically the same, except that the latter is remotely controlled.

FIELD SURVEY REPORT EXCERPTS

J11 **DATE:** 11-6-79 CAUSE NO. 1

AFB: J	**AIRCRAFT:** FB-111A	**AN/DESIGNATOR:** APN-167/ALTIMETER

DEBRIEFING OBSERVATIONS

Debriefing takes place 10 to 15 minutes after touchdown (can take up to 30 minutes). Code 1 (no A/C squawks) rarely occurs. Completes TAC Form 122 for O-level shop. Flight Analysis uses AFTO Form 781. Identifies repeat/recurring failures.

O-LEVEL OBSERVATIONS

Press-to-test light indicates that system is operative. Responds to Job Control AFTO Form 349 via hotline or intercom. Attempt is made to duplicate any squawk, or will remove and replace suspect LRU. O-level uses ohmmeter for RF cable check. (Note: I-level shop chief believes that if I-level pulled their own LRUs at O-level, this would significantly lower the UR rate.)

I-LEVEL OBSERVATIONS

Uses automatic test station but does not calibrate certain meters. I-level performs fault isolation automatically to an indicated faulty SRU, then verifies with substitutes of known good SRUs. "I" adapter for R/T LRU has blind insertion of LRU into holding fixture: high probability of shorting 50-volt line to ground (smoking power supply). No mechanical guides inside box assembly. Automatic test equipment is ten years old, and beginning to show wearout.

RECORDS AND FORMS USED

AFTO Form 349 is completed by debriefing group — one copy goes to Job Control. I-level shop completes AFTO Form 95 which is filed by Work Unit Code (WUC), then they "file" the AFTO Form 349. AMS Analysis input to data base via AFTO Form 349.

COMMENTS

Qualitative features: BIT type is Go/No Go only.

FIELD SURVEY REPORT EXCERPTS

J37 **DATE:** 11-6-79 CAUSE NO. 6

AFB: J	**AIRCRAFT:** KC-135	**AN/DESIGNATOR:** ARC-164/UHF Radio

DEBRIEFING OBSERVATIONS

Debriefing accomplished in about 30 minutes, about 10 to 15 minutes after A/C recovery. Aircrew, MS shop representative and debriefer are in attendance. "Local form" is used for O-level. Aircrew completes AFTO Form 781, which is used by the AMS Analysis. AFTO Form 349 is completed for squawks, a copy is forwarded to Job Control.

O-LEVEL OBSERVATIONS

Performs A/C verification of squawks. Performs removal and replacement of suspect LRUs. No on-A/C alignment is performed. O-level and I-level shops are combined. O-level support test equipment are referenced in T.O.s, but are not used. Troubleshooting consists of attempted operation, removal, bench check and replace; or by substitution. Modularity design of system, with most electronics in one LRU, aids in the maintenance process.

I-LEVEL OBSERVATIONS

Fault isolation of suspect LRUs to SRU level by test using a hot mock-up. Faulty SRUs are routed to depot for repair. When any LRU is considered "beyond capability of maintenance," it is routed to depot for repair. O-level and I-level personnel and activities are combined under one supervisor supporting the KC-135 avionics.

RECORDS AND FORMS USED

AFTO Form 781, AFTO Form 349 and AFTO Form 95 (as well as "local forms") are completed. I-level shop completes AFTO Form 95 and maintains it in file by WUC number: then files AFTO Form 349. AFTO Form 349 is sent to AMS Analysis.

COMMENTS

Sortie Class 1 (no A/C squawks) rarely occurs. A typical KC-135 debrief will have about 10 squawks.

FIELD SURVEY REPORT EXCERPTS

J21 **DATE:** 11-7-79 CAUSE NO. 1

AFB: J	**AIRCRAFT:** KC-135	**AN/DESIGNATOR:** ARN-118/TACAN

DEBRIEFING OBSERVATIONS

Debriefing takes place 15 to 45 minutes after A/C recovery. Debriefing is done by interviews with pilot, co-pilot, navigator and boom operator. AMU shop representatives are present when problem systems are squawked. Repeat/recurring failures are generally identified. Aircrew documents malfunctions on AFTO Form 781, for use at debriefing.

O-LEVEL OBSERVATIONS

Press-to-test lamp and BIT is used in-flight and post-flight for equipment function verification. O-level and I-level are combined under one supervisor for this equipment. Fault isolation is by substitution of LRUs.

I-LEVEL OBSERVATIONS

I-level and O-level efforts are combined under one supervisor. I-level answers AFTO Form 349 squawks, received from Job Control group via phone or intercom. Suspect LRU is fault isolated on hot mock-up. Faulty LRUs are sent to contractor's depot facility for repair in accordance with RIW contract. The same test procedures used by I-level are used by the contractor's depot, as required by the terms of the RIW contract.

RECORDS AND FORMS USED

Debriefer completes AFTO Form 349 and sends copy to Job Control. I-level shop completes AFTO Form 95 and maintains these in file by WUC number. Monthly summary reports (RIW) are forwarded by Contractor depot to WR-ALC. AFTO Form 349 is sent to AMS Analysis.

COMMENTS

All LRUs received at contractor's depot are tested prior to cleaning and repairing operations. Each LRU is tested on a hot mock-up.

FIELD SURVEY REPORT EXCERPTS

K29 **DATE:** 12-12-79 CAUSE NO. 7

AFB: K	AIRCRAFT: T-38	AN/DESIGNATOR: ARC-164/UHF Radio

DEBRIEFING OBSERVATIONS

There is no debriefing per se. Pilot writes-up squawks on AFTO Form 781. Crew chief is on the flightline to talk to pilots. If malfunction is reported, crew chief calls Job Control, who notifies appropriate I-level shop personnel on hot line, and orders dispatch of maintenance specialist for repairs. Job Control completes AFTO Form 349.

O-LEVEL OBSERVATIONS

Troubleshooting by substitution, with two-hour turnaround. The Field Maintenance Squadron supports the T-37, T-38 and T-39 squadrons. System is modular, with the majority of the electronics contained in one LRU. CNDs at flightline are frequently "signed-off" as CNDs, but these are watched for any repeat write-ups.

I-LEVEL OBSERVATIONS

I-level dispatches personnel to support the flightline. A "support truck" full of spare LRUs, for use in the substitution practice, is available at the flightline. A/C turnaround time is about two hours. Suspect LRUs are bench checked on hot mock-up to SRU level. Faulty SRU is routed to depot for repair. I-level shop maintains no records.

RECORDS AND FORMS USED

AFTO Form 781 completed by pilot. AFTO Form 349 completed, as necessary. Debriefing maintains copy of AFTO Form 349 for about one year: filed by A/C number. AFTO Form 349, at I-level shop, is keypunched and furnished to AMS Analysis: another copy is maintained, as A/C history, on the "support truck," for trend analysis.

COMMENTS

Aircraft mission is to provide undergraduate pilot training.

FIELD SURVEY REPORT EXCERPTS

K25 **DATE:** 12-12-79 CAUSE NOS. 4,7

AFB: K	**AIRCRAFT:** T-38	**AN/DESIGNATOR:** ARN-118/TACAN

DEBRIEFING OBSERVATIONS

The crew chief meets each arriving A/C and receives squawks from the pilot. Discrepancies are phoned to Job Control. Job Control assigns a Job Control Number for use in I-level shops. Repeat/recurring failures are identified: AFTO Form 349 are filed by A/C serial number (for periods up to one year).

O-LEVEL OBSERVATIONS

Maintenance at O-level consists of reseating LRUs, tightening cable connectors, replacement of cables or switching LRUs. A "maintenance truck" with a full compliment of spares is dispatched upon call from the crew chief. Personnel from I-level staff the truck and troubleshoot at the flightline. Available test equipment is seldom used because set-up time is too long; therefore, maintenance personnel find it more expeditious to remove and replace LRUs.

I-LEVEL OBSERVATIONS

Provides only functional checks of suspect LRUs by use of test at hot mock-up. Faulty LRU is forwarded to contractor's depot for repair, under terms of RIW contract. Depot tests suspect LRU using hot mock-up. The same procedures used in I-level are used at depot, as required by contract.

RECORDS AND FORMS USED

AFTO Form 349 is initiated upon receipt of squawk by Job Control, where a Job Control Number is assigned and shop responsibility is delegated. The squawk (malfunction) can either be cleared at the A/C or the suspect LRU is replaced with a good LRU from the "maintenance truck." Records are not kept at I-level, copies of AFTO Form 349 are retained on maintenance truck for one year.

COMMENTS

BIT is available but seldom used at this AFB. Operational committment of the A/C requires a rapid turnaround time.

FIELD SURVEY REPORT EXCERPTS

L30 **DATE:** 2-6-80 CAUSE NO. 7

AFB: L	**AIRCRAFT:** F-5E	**AN/DESIGNATOR:** ARC-164/UHF Radio

DEBRIEFING OBSERVATIONS

The pilots are debriefed at the A/C by the crew chief, immediately after landing. The pilot furnishes a completed AFTO Form 781 to the crew chief. AFTO Form 349 is completed for each A/C discrepancy, and copy is forwarded to the Job Control group (and then dispatched to the respective repair shops). This AFB has 23 F-5E, 2 F-5F and 9 F-5B A/C, but for this study all URs of these A/C are listed under the F-5E designation.

O-LEVEL OBSERVATIONS

O-level removes and replaces suspect LRUs. Suspect LRUs are routed to I-level bench check. Replacements are from Supply or returned from I-level. The O-level jobs are dispatched via "hot line" or other telephones from Job Control. The personnel are dispatched from the I-level shop to accomplish O-level maintenance. The Communication-Navigation Maintenance Section has a "red ball vehicle" to expedite fast turnaround sorties, at the flightline.

I-LEVEL OBSERVATIONS

Maintenance instructions are to isolate a fault to an SRU. Fault isolation consists of performance test and trouble analysis procedures. The trouble analysis procedures are given in the form of logic flow charts. After a fault has been isolated, repair instructions are provided. Repair instructions consist of removal and replacement instructions or adjustment procedures. Depot-level repairs SRUs.

RECORDS AND FORMS USED

Pilot completes AFTO Form 781. AFTO Form 349 files are maintained for on-equipment and off-equipment: filed by A/C number and WUC numbers. All equipment received at depot for repair should have an AFTO Form 350 (tag) and a green condition tag (DD Form 1577-2) attached. All have green tag and most have AFTO Form 350 tags.

COMMENTS

The RT-1168 and RT-1145 are basically the same LRU except that the latter is remotely controlled.

FIELD SURVEY REPORT EXCERPTS

L40 **DATE:** 2-6-80 CAUSE NO. 7

AFB: L	AIRCRAFT: T-38	AN/DESIGNATOR: ARC-164/UHF Radio

DEBRIEFING OBSERVATIONS

There is no debriefing per se. Pilot is debriefed by crew chief on the flightline. The Communications/Navigation maintenance shop has a flightline "support truck" that is available upon phone call from the crew chief. Debriefing talk takes place upon A/C recovery. Repeat/recurring failures are identified.

O-LEVEL OBSERVATIONS

Because of the high utilization and short turnaround time (1-1/2 to 2 hours) of sorties, squawks by pilots are first checked operationally on the A/C and then suspect LRU is removed for I-level bench check (check and removal requires about 45 minutes). Modular design and simple mounting permits easy removal of LRUs.

I-LEVEL OBSERVATIONS

I-level shop has its own flightline support (truck) with good spares available. There is, generally, no time to use hot mock-up test equipment for fault isolation, and squawks are resolved as described above (see "O-level Observations"). If LRU checks OK at bench check, the LRU is reinstalled and everyone is alert to any repeat write-ups. If LRU is faulty, another LRU is subtituted from Supply. If Supply has no LRU available, LRU is cannibalized from another A/C.

RECORDS AND FORMS USED

AFTO Form 349 is initiated for LRUs removed from A/C. Removal actions will only be documented on AFTO Form 349 if there is an LRU repair action taken (otherwise, the LRU is simply reinstalled). AFTO Form 349 is maintained for on-equipment and off-equipment maintenance actions: filed by A/C number and WUC number. Equipment history (anything serialized) is maintained.

COMMENTS

Aircraft mission is to provide undergraduate pilot training.

FIELD SURVEY REPORT EXCERPTS

L24 **DATE:** 2-6-80 CAUSE NOS. 1,7

AFB: L	AIRCRAFT: T-38	AN/DESIGNATOR: ARN-118/TACAN

DEBRIEFING OBSERVATIONS

Pilots are debriefed at the aircraft by the crew chief, immediately after landing. Pilot completes AFTO Form 781. Repeat and recurring failures are identified.

O-LEVEL OBSERVATIONS

BIT, initiated from the cockpit, provides visibility of test azimuth, range (DME), problem indicator light, flag indication and test tone. LRUs are configured as one unit, therefore the complete assembly is removed for routing to I-level bench check. As noted in the "Comments" below, only the replaced LRU is documented. The Communication-Navigation Maintenance Section has a "red-ball vehicle" with spare LRUs, to expedite fast turnaround sorties, at the flightline.

I-LEVEL OBSERVATIONS

When complete assembly is bench checked, only the faulty LRU is replaced and documented. Faulty LRU is verified by test using hot mock-up. No repair is authorized at I-level maintenance. Faulty LRU is forwarded to contractor's depot for repair, under RIW contract terms.

RECORDS AND FORMS USED

AFTO Form 349 is created for each A/C discrepancy and copies forwarded to Job Control and to respective shops. AFTO Form 349 files are maintained for on-equipment and off-equipment work: filed by A/C number and WUC number. Equipment history is maintained for each LRU serial number and equipment designator.

COMMENTS

At I-level, only the faulty LRU is documented in the MDC system.

APPENDIX C

1978 DATA RECORDS

KEY:

PR REMOVALS = Removals based on Action Taken Code P and Action Taken Code R.

MTCH FAIL = Number of removals found to be Type 1 HOW MAL codes.

UNMA FAIL = Number of unmatched removals (those due to missing shop records).

BCS REM = Number of "Bench Checked - Serviceables."

SCURAE STUDY REMOVAL ACTION DATA SUMMARY--BASE A

WEAPON SYSTEM B1 OP CMND SAC — DATA WINDOW - 12 MONTHS
EQ NO 45 — PERIOD ENDING - DEC78
EQ FUNCTION COMM UHF — PART I
EQ IDENT WUC 63EA0 LRU 11 EQ DESCR: REC/XMTR

----HOW MALFUNCTIONED----		----PR REMOVALS----			--TOTAL PR REMOVALS--	
CODE	NOUN	MTCH FAIL	UNMA FAIL	BCS REM	UNITS	MHRS
008	NOISY		1		1	1.0
051	FAILS TO TUNE/DRIFT			2	2	8.0
255	NO/INCORR OUTPUT	4	3		7	9.8
693	AUDIO FAULTY	9	7		16	38.0
	WUC TOTAL	13	11	2	26	56.8

SCURAE STUDY REMOVAL ACTION DATA SUMMARY--BASE A

WEAPON SYSTEM B1 OP CMND SAC — DATA WINDOW - 12 MONTHS
EQ NO 45 — PERIOD ENDING - DEC78
EQ FUNCTION COMM UHF — PART I
EQ IDENT WUC 63EBA LRU 13 EQ DESCR: CONTROL

----HOW MALFUNCTIONED----		----PR REMOVALS----			--TOTAL PR REMOVALS--	
CODE	NOUN	MTCH FAIL	UNMA FAIL	BCS REM	UNITS	MHRS
051	FAILS TO TUNE/DRIFT		2		2	8.0
255	NO/INCORR OUTPUT		1		1	.2
693	AUDIO FAULTY		2		2	5.0
748	FREQ ERRATIC/INCORR		2		2	8.0
	WUC TOTAL		7		7	21.2

SCORAE STUDY REMOVAL ACTION DATA SUMMARY--BASE A

WEAPON SYSTEM B1 OP CMND SAC — DATA WINDOW - 12 MONTHS
EQ NO 44 — PERIOD ENDING - DEC78
EQ FUNCTION NAVIGATION — PART I
EQ IDENT WUC 71ZA0 LRU 11 EQ DESCR: REC/XMTR

----HOW MALFUNCTIONED----		----PR REMOVALS----			--TOTAL PR REMOVALS--	
CODE	NOUN	MTCH FAIL	UNMA FAIL	BCS REM	UNITS	MHRS
255	NO/INCORR OUTPUT	1	9	13	23	50.1
383	LOCK ON MALFUNCTION	1	1	3	5	18.0
657	DISTANCE MEAS ERROR		1	2	3	11.0
658	BRG DEST STA ERROR			1	1	1.0
693	AUDIO FAULTY		1	1	2	1.3
901	INTERMITTENT			3	3	9.0
	WUC TOTAL	2	12	23	37	90.4

SCORAE STUDY REMOVAL ACTION DATA SUMMARY--BASE A

WEAPON SYSTEM B1 OP CMND SAC — DATA WINDOW - 12 MONTHS
EQ NO 44 — PERIOD ENDING - DEC78
EQ FUNCTION NAVIGATION — PART I
EQ IDENT WUC 71ZB0 LRU 12 EQ DESCR: D/A CONV

----HOW MALFUNCTIONED----		----PR REMOVALS----			--TOTAL PR REMOVALS--	
CODE	NOUN	MTCH FAIL	UNMA FAIL	BCS REM	UNITS	MHRS
051	FAILS TO TUNE/DRIFT	1			1	4.0
255	NO/INCORR OUTPUT	3	6	11	20	36.6
383	LOCK ON MALFUNCTION			2	2	2.5
601	DETONATION			1	1	1.0
657	DISTANCE MEAS ERROR			1	1	1.0
658	BRG DEST STA ERROR	1			1	1.0
901	INTERMITTENT	2		1	3	5.5
	WUC TOTAL	7	6	16	29	51.6

SCURAE STUDY REMOVAL ACTION DATA SUMMARY--BASE A

WEAPON SYSTEM BI OP CMND SAC — DATA WINDOW - 12 MONTHS
EQ NO 44 — PERIOD ENDING - DEC78
EQ FUNCTION NAVIGATION — PART I
EQ IDENT WUC 71ZD0 LRU 14 EQ DESCR: CONTROL

----HOW MALFUNCTIONED---- CODE	NOUN	----PR REMOVALS---- MTCH FAIL	UNMA FAIL	BCS REM	--TOTAL PR REMOVALS-- UNITS	MHRS
070	BROKEN	1			1	.5
255	NO/INCORR OUTPUT		3		3	4.0
	WUC TOTAL	1	3		4	4.5

C-4

SCURAE STUDY REMOVAL ACTION DATA SUMMARY--BASE A

WEAPON SYSTEM CL OP CMND SAC — DATA WINDOW - 12 MONTHS
EQ NO 45 — PERIOD ENDING - DEC78
EQ FUNCTION COMM UHF — PART I
EQ IDENT WUC 63RA0 LRU 11 EQ DESCR: REC/XMTR

----HOW MALFUNCTIONED---- CODE	NOUN	----PR REMOVALS---- MTCH FAIL	UNMA FAIL	BCS REM	--TOTAL PR REMOVALS-- UNITS	MHRS
051	FAILS TO TUNE/DRIFT	2	1		3	9.0
255	NO/INCORR OUTPUT	1	1		2	3.0
693	AUDIO FAULTY	8	4		12	29.5
901	INTERMITTENT	1			1	4.0
	WUC TOTAL	12	6		18	45.5

SCURAE STUDY REMOVAL ACTION DATA SUMMARY--BASE A

WEAPON SYSTEM CL OP CMND SAC DATA WINDOW - 12 MONTHS
EQ NO 45 PERIOD ENDING - DEC78
EQ FUNCTION COMM UHF PART I
EQ IDENT WUC 63RB0 LRU 12 EQ DESCR: CONTROL

----HOW MALFUNCTIONED---- CODE	NOUN	----PR REMOVALS---- MTCH FAIL	UNMA FAIL	BCS REM	--TOTAL PR REMOVALS-- UNITS	MHRS
255	NO/INCORR OUTPUT		1		1	1.0
693	AUDIO FAULTY	1	3		4	5.0
730	LOOSE		2		2	4.0
	WUC TOTAL	1	6		7	10.0

SCURAE STUDY REMOVAL ACTION DATA SUMMARY--BASE A

WEAPON SYSTEM CL OP CMND SAC DATA WINDOW - 12 MONTHS
EQ NO 44 PERIOD ENDING - DEC78
EQ FUNCTION NAVIGATION PART 1
EQ IDENT WUC 71ZA0 LRU 11 EQ DESCR: REC/XMTR

----HOW MALFUNCTIONED---- CODE	NOUN	----PR REMOVALS---- MTCH FAIL	UNMA FAIL	BCS REM	--TOTAL PR REMOVALS-- UNITS	MHRS
255	NO/INCORR OUTPUT	1	2	1	4	8.8
657	DISTANCE MEAS ERROR		1		1	4.0
710	BRNG FAILURE/FAULTY			1	1	1.0
	WUC TOTAL	1	3	2	6	13.8

SCURAE STUDY REMOVAL ACTION DATA SUMMARY--BASE A

WEAPON SYSTEM CL OP CMND SAC DATA WINDOW - 12 MONTHS
EQ NO 44 PERIOD ENDING - DEC78
EQ FUNCTION NAVIGATION PART I
EQ IDENT WUC 71ZB0 LRU 12 EQ DESCR: D/A CONV

----HOW MALFUNCTIONED---- CODE	NOUN	----PR REMOVALS---- MTCH FAIL	UNMA FAIL	BCS REM	--TOTAL PR REMOVALS-- UNITS	MHRS
255	NO/INCORR OUTPUT	1	2	1	4	8.5
657	DISTANCE MEAS ERROR		1		1	4.0
710	BRNG FAILURE/FAULTY	1			1	1.0
	WUC TOTAL	2	3	1	6	13.5

SCURAE STUDY REMOVAL ACTION DATA SUMMARY--BASE A

WEAPON SYSTEM CL OP CMND SAC DATA WINDOW - 12 MONTHS
EQ NO 44 PERIOD ENDING - DEC78
EQ FUNCTION NAVIGATION PART I
EQ IDENT WUC 71Z00 LRU 14 EQ DESCR: CONTROL

----HOW MALFUNCTIONED---- CODE	NOUN	----PR REMOVALS---- MTCH FAIL	UNMA FAIL	BCS REM	--TOTAL PR REMOVALS-- UNITS	MHRS
070	BROKEN		1		1	6.0
255	NO/INCORR OUTPUT		1		1	2.0
	WUC TOTAL		2		2	8.0

SCURAE STUDY REMOVAL ACTION DATA SUMMARY--BASE B

WEAPON SYSTEM AM UP CMND TAC
EQ NO 45
EQ FUNCTION COMM UHF
EQ IDENT WUC 63AA0 LRU 11 EQ DESCR: REC/XMTR

DATA WINDOW - 12 MONTHS
PERIOD ENDING - DEC78
PART I

----HOW MALFUNCTIONED----		----PR REMOVALS----			--TOTAL PR REMOVALS--	
CODE	NOUN	MTCH FAIL	UNMA FAIL	BCS REM	UNITS	MHRS
008	NOISY	1	2		3	6.1
051	FAILS TO TUNE/DRIFT			1	1	1.0
088	INCORRECT GAIN	1			1	.5
255	NO/INCURR OUTPUT	10	6	7	23	47.8
693	AUDIO FAULTY	2	1	4	7	16.1
695	SYNC ABS/INCORRECT	1			1	2.3
748	FREQ ERRATIC/INCORR	4			4	4.1
901	INTERMITTENT	1	3	1	5	10.3
958	INCORRECT DISPLAY		1		1	4.0
	WUC TOTAL	20	13	13	46	92.2

SCURAE STUDY REMOVAL ACTION DATA SUMMARY--BASE B

WEAPON SYSTEM AM OP CMND TAC — DATA WINDOW - 12 MONTHS
EQ NO 53 — PERIOD ENDING - DEC78
EQ FUNCTION IFF — PART I
EQ IDENT WUC 65AA0 LRU 11 EQ DESCR: REC/XMTR

----HOW MALFUNCTIONED----		----PR REMOVALS----			--TOTAL PR REMOVALS--	
CODE	NOUN	MTCH FAIL	UNMA FAIL	BCS REM	UNITS	MHRS
255	NO/INCORR OUTPUT	16	3	6	25	58.3
290	FAILS TEST	2		1	3	6.5
374	INTERNAL FAILURE		1		1	2.5
901	INTERMITTENT	3	1	1	5	8.2
	WUC TOTAL	21	5	8	34	75.5

SCURAE STUDY REMOVAL ACTION DATA SUMMARY--BASE B

WEAPON SYSTEM AM OP CMND TAC — DATA WINDOW - 12 MONTHS
EQ NO 44 — PERIOD ENDING - DEC78
EQ FUNCTION NAVIGATION — PART I
EQ IDENT WUC 71ZA0 LRU 11 EQ DESCR: REC/XMTR

----HOW MALFUNCTIONED----		----PR REMOVALS----			--TOTAL PR REMOVALS--	
CODE	NOUN	MTCH FAIL	UNMA FAIL	BCS REM	UNITS	MHRS
255	NO/INCORR OUTPUT	4	2	3	9	22.0
383	LOCK ON MALFUNCTION			1	1	1.5
658	BRG DEST STA ERROR	1			1	3.0
901	INTERMITTENT		1	3	4	6.8
	WUC TOTAL	5	3	7	15	33.3

SCURAE STUDY REMOVAL ACTION DATA SUMMARY--BASE B

WEAPON SYSTEM AM OP CMND TAC
EQ NO 44
EQ FUNCTION NAVIGATION
EQ IDENT WUC 71Z80 LRU 12 EQ DESCR: D/A CONV

DATA WINDOW - 12 MONTHS
PERIOD ENDING - DEC78
PART 1

----HOW MALFUNCTIONED---- CODE	NOUN	----PR REMOVALS---- MTCH FAIL	UNMA FAIL	BCS REM	--TOTAL PR REMOVALS-- UNITS	MHRS
255	NO/INCORR OUTPUT	1	3	2	6	10.0
383	LOCK ON MALFUNCTION			1	1	1.0
658	BRG DEST STA ERROR	1			1	2.0
901	INTERMITTENT			2	2	4.0
	WUC TOTAL	2	3	5	10	17.0

SCURAE STUDY REMOVAL ACTION DATA SUMMARY--BASE B

WEAPON SYSTEM AM OP CMND TAC
EQ NO 44
EQ FUNCTION NAVIGATION
EQ IDENT WUC 71Z00 LRU 14 EQ DESCR: CONTROL

DATA WINDOW - 12 MONTHS
PERIOD ENDING - DEC78
PART 1

----HOW MALFUNCTIONED---- CODE	NOUN	----PR REMOVALS---- MTCH FAIL	UNMA FAIL	BCS REM	--TOTAL PR REMOVALS-- UNITS	MHRS
080	DEFECTIVE LAMP	1			1	2.0
190	CRACKED		1		1	1.0
255	NO/INCORR OUTPUT	4	1		5	7.5
385	LOCK ON MALFUNCTION	1			1	1.0
748	FREQ ERRATIC/INCORR	1			1	3.0
901	INTERMITTENT	1	1		2	3.0
	WUC TOTAL	8	3		11	17.5

SCURAE STUDY REMOVAL ACTION DATA SUMMARY--BASE E

WEAPON SYSTEM AR OP CMND TAC — DATA WINDOW - 12 MONTHS
EQ NO 45 — PERIOD ENDING - DEC78
EQ FUNCTION COMM UHF — PART I
EQ IDENT WUC 63CA0 LRU 11 EQ DESCR: REC/XMTR

----HOW MALFUNCTIONED---- CODE	NOUN	----PR REMOVALS---- MTCH FAIL	UNMA FAIL	BCS REM	--TOTAL PR REMOVALS-- UNITS	MHRS
255	NO/INCORR OUTPUT	1	1		2	3.0
693	AUDIO FAULTY	2	1	1	4	13.0
901	INTERMITTENT		1		1	2.0
	WUC TOTAL	3	3	1	7	18.0

SCURAE STUDY REMOVAL ACTION DATA SUMMARY--BASE E

WEAPON SYSTEM AR OP CMND TAC — DATA WINDOW - 12 MONTHS
EQ NO 45 — PERIOD ENDING - DEC78
EQ FUNCTION COMM UHF — PART I
EQ IDENT WUC 63CB0 LRU 12 EQ DESCR: CONTROL

----HOW MALFUNCTIONED---- CODE	NOUN	----PR REMOVALS---- MTCH FAIL	UNMA FAIL	BCS REM	--TOTAL PR REMOVALS-- UNITS	MHRS
070	BROKEN	2			2	4.0
255	NO/INCORR OUTPUT	1	2		3	14.0
693	AUDIO FAULTY		2		2	1.0
	WUC TOTAL	3	4		7	19.0

SCURAE STUDY REMOVAL ACTION DATA SUMMARY--BASE E

WEAPON SYSTEM AR OP CMND TAC
EQ NO 44
EQ FUNCTION NAVIGATION
EQ IDENT WUC 71ZA0 LRU 11 EQ DESCR: REC/XMTR

DATA WINDOW - 12 MONTHS
PERIOD ENDING - DEC78
PART I

----HOW MALFUNCTIONED---- CODE	NOUN	----PR REMOVALS---- MTCH FAIL	UNMA FAIL	BCS REM	--TOTAL PR REMOVALS-- UNITS	MHRS
255	NO/INCORR OUTPUT	3	4	2	9	24.0
383	LOCK ON MALFUNCTION		4		4	9.3
657	DISTANCE MEAS ERROR	1			1	.5
658	BRG DEST STA ERROR	1			1	2.0
	WUC TOTAL	5	8	2	15	35.8

SCURAE STUDY REMOVAL ACTION DATA SUMMARY--BASE E

WEAPON SYSTEM AR OP CMND TAC
EQ NO 44
EQ FUNCTION NAVIGATION
EQ IDENT WUC 71ZB0 LRU 12 EQ DESCR: D/A CONV

DATA WINDOW - 12 MONTHS
PERIOD ENDING - DEC78
PART I

----HOW MALFUNCTIONED---- CODE	NOUN	----PR REMOVALS---- MTCH FAIL	UNMA FAIL	BCS REM	--TOTAL PR REMOVALS-- UNITS	MHRS
255	NO/INCORR OUTPUT	1	4		5	15.0
383	LOCK ON MALFUNCTION	1	3		4	7.3
657	DISTANCE MEAS ERROR	1			1	4.0
	WUC TOTAL	3	7		10	26.3

SCURAE STUDY REMOVAL ACTION DATA SUMMARY--BASE E

WEAPON SYSTEM AR OP CMND TAC DATA WINDOW - 12 MONTHS
EQ NO 44 PERIOD ENDING - DEC78
EQ FUNCTION NAVIGATION PART 1
EQ IDENT WUC 71ZC0 LRU 13 EQ DESCR: MOUNT

----HOW MALFUNCTIONED----		----PR REMOVALS----			--TOTAL PR REMOVALS--	
CODE	NOUN	MTCH FAIL	UNMA FAIL	BCS REM	UNITS	MHRS
255	NO/INCORR OUTPUT	1	1		2	4.3
	WUC TOTAL	1	1		2	4.3

SCURAE STUDY REMOVAL ACTION DATA SUMMARY--BASE E

WEAPON SYSTEM AR OP CMND TAC DATA WINDOW - 12 MONTHS
EQ NO 44 PERIOD ENDING - DEC78
EQ FUNCTION NAVIGATION PART I
EQ IDENT WUC 71ZD0 LRU 14 EQ DESCR: CONTROL

----HOW MALFUNCTIONED----		----PR REMOVALS----			--TOTAL PR REMOVALS--	
CODE	NOUN	MTCH FAIL	UNMA FAIL	BCS REM	UNITS	MHRS
070	BROKEN	4	4		8	10.8
127	ADJUSTMENT IMPROPER		4		4	2.6
190	CRACKED		1		1	1.0
255	NO/INCORR OUTPUT	3	1	2	6	8.5
383	LOCK ON MALFUNCTION		1		1	1.5
657	DISTANCE MEAS ERROR		1		1	.4
	WUC TOTAL	7	12	2	21	24.8

SCURAE STUDY REMOVAL ACTION DATA SUMMARY--BASE E

WEAPON SYSTEM AR OP CMND TAC
EQ NO 27
EQ FUNCTION INSTRUMENT
EQ IDENT WUC 73FA0 LRU 11 EQ DESCR: IM UNIT

DATA WINDOW - 12 MONTHS
PERIOD ENDING - DEC78
PART 1

----HOW MALFUNCTIONED---- CODE	NOUN	----PR REMOVALS---- MTCH FAIL	UNMA FAIL	BCS REM	--TOTAL PR REMOVALS-- UNITS	MHRS
051	FAILS TO TUNE/DRIFT			1	1	1.0
127	ADJUSTMENT IMPROPER	1	6	4	11	32.8
242	FAILED TO OPERATE			1	1	1.0
607	NOGO-REASON UNKNOWN	2	2	7	11	16.0
622	WET/CONDENSATION		1		1	2.0
631	BIAS VOLTAGE INCORR		1		1	1.0
652	AUTOALIGNTIME EXCES	5	2	2	9	23.1
653	GS ERROR EXCESSIVE		4	4	8	13.9
654	TERMINAL ERROR-CEP	9	7	21	37	91.4
655	TERMINAL ERROR-RANG			2	2	5.0
656	TERMINAL ERROR-AZIM	17	7	25	49	144.8
657	DISTANCE MEAS ERROR	4	3	14	22	73.8
658	BRG DEST STA ERROR	7	6	18	31	111.2
956	ABN FNCT OF COMP ME			1	1	3.5
958	INCORRECT DISPLAY	5	8	7	20	41.9
	WUC TOTAL	50	47	107	205	562.4

SCURAE STUDY REMOVAL ACTION DATA SUMMARY--BASE E

WEAPON SYSTEM AR OP CMND TAC DATA WINDOW - 12 MONTHS
EQ NO 27 PERIOD ENDING - DEC78
EQ FUNCTION INSTRUMENT PART I
EQ IDENT WUC 73FC0 LRU 13 EQ DESCR: CONTROL IMS

----HOW MALFUNCTIONED----		----PR REMOVALS----			--TOTAL PR REMOVALS--	
CODE	NOUN	MTCH FAIL	UNMA FAIL	BCS REM	UNITS	MHRS
070	BROKEN	3	4		7	13.0
080	DEFECTIVE LAMP	1			1	1.0
127	ADJUSTMENT IMPROPER	1			1	5.8
135	BINDING	1	1		2	2.8
190	CRACKED	1			1	2.5
290	FAILS TEST		1		1	1.0
656	TERMINAL ERROR-AZIM	1			1	1.0
657	DISTANCE MEAS ERROR	1		1	2	5.0
660	STRIPPED	1			1	4.0
730	LOOSE	2	1		3	5.5
910	CHIPPED	1			1	.7
958	INCORRECT DISPLAY		1		1	2.3
	WUC TOTAL	13	6	1	22	44.6

SCURAE STUDY REMOVAL ACTION DATA SUMMARY--BASE E

WEAPON SYSTEM AR OP CMND TAC
EQ NO 27
EQ FUNCTION INSTRUMENT
EQ IDENT WUC 73F00 LRU 14 EQ DESCR: POW SUP ADAP

DATA WINDOW - 12 MONTHS
PERIOD ENDING - DEC78
PART I

----HOW MALFUNCTIONED---- CODE	NOUN	----PR REMOVALS---- MTCH FAIL	UNMA FAIL	BCS REM	--TOTAL PR REMOVALS-- UNITS	MHRS
051	FAILS TO TUNE/DRIFT	1		1	2	3.0
127	ADJUSTMENT IMPROPER	4	1	2	7	25.0
169	INCORRECT VOLTAGE	1			1	1.0
242	FAILED TO OPERATE		3		3	3.7
255	NO/INCURR OUTPUT	2		1	3	13.3
290	FAILS TEST		2		2	4.0
383	LOCK ON MALFUNCTION		1	1	2	4.5
607	NOGO-REASON UNKNOWN	2	1	10	13	31.0
652	AUTOALIGNTIME EXCES	8	5	11	24	55.8
653	GS ERROR EXCESSIVE	1	4	1	6	6.6
654	TERMINAL ERROR-CEP	6	1	15	22	43.8
656	TERMINAL ERROR-AZIM	8	5	9	22	52.1
657	DISTANCE MEAS ERROR	1	2	5	8	16.0
658	BRG DEST STA ERROR	11	7	18	36	116.0
958	INCORRECT DISPLAY	4	8	16	28	50.6
	WUC TOTAL	49	40	90	179	426.4

SCURAE STUDY REMOVAL ACTION DATA SUMMARY--BASE F

WEAPON SYSTEM FB OP CMND TAC — DATA WINDOW - 12 MONTHS
EQ NO 53 — PERIOD ENDING - DEC78
EQ FUNCTION IFF — PART I
EQ IDENT WUC 65AA0 LRU 11 EQ DESCR: REC/XMTR

----HOW MALFUNCTIONED----		----PR REMOVALS----			--TOTAL PR REMOVALS--	
CODE	NOUN	MTCH FAIL	UNMA FAIL	BCS REM	UNITS	MHRS
037	FLUCTUATES	1			1	3.0
135	BINDING		1		1	2.0
242	FAILED TO OPERATE	2	1	1	4	12.5
255	NO/INCORR OUTPUT	2	3	1	6	43.7
290	FAILS TEST	7	3	4	14	56.8
607	NOGO-REASON UNKNOWN	2			2	10.5
721	IMP RESP TO ELEC IN	1		1	2	7.0
901	INTERMITTENT	1			1	4.0
	WUC TOTAL	16	8	7	31	139.5

SCURAE STUDY REMOVAL ACTION DATA SUMMARY--BASE F

WEAPON SYSTEM FB OP CMND TAC — DATA WINDOW - 12 MONTHS
EQ NO 05 — PERIOD ENDING - DEC78
EQ FUNCTION RADAR FC — PART I
EQ IDENT WUC 74F00 LRU 18 EQ DESCR: R DATA PROC

----HOW MALFUNCTIONED----		----PR REMOVALS----			--TOTAL PR REMOVALS--	
CODE	NOUN	MTCH FAIL	UNMA FAIL	BCS REM	UNITS	MHRS
037	FLUCTUATES	1	1	1	3	5.5
070	BROKEN		1		1	4.2
103	ATTACK DISP MALFUNC	1	1		2	4.3
169	INCORRECT VOLTAGE			2	2	2.3
242	FAILED TO OPERATE	2	11	5	18	46.3
255	NO/INCORR OUTPUT	6	3	1	10	25.6
290	FAILS TEST	11	7	11	29	119.6
334	TEMP INCORRECT			1	1	3.5
383	LOCK ON MALFUNCTION		2		2	6.2
583	PRSNTATION INCORREC			1	1	4.0
649	SWEEP MALFUNCTION		1		1	.5
657	DISTANCE MEAS ERROR	1			1	2.0
711	IMPROPER BLANKING		1		1	4.0
718	IMP RESP TO MECH IN			1	1	3.0
721	IMP RESP TO ELEC IN	2	4	4	10	40.3
748	FREQ ERRATIC/INCORR		1		1	1.5
780	BENT	5			5	14.5
900	BURNED			1	1	.5
901	INTERMITTENT	2		1	3	11.0
941	NON-PROGRAMMED FAUL	1		2	3	6.8
943	DATA ERROR	1			1	.5
946	INCOMPL/NO PRINTOUT		1		1	1.5
956	ABN FNCT OF COMP ME		1		1	4.0
957	NO DISPLAY	4	2	2	8	25.0
958	INCORRECT DISPLAY			1	1	4.3
961	HIGH ANODE CURRENT	1			1	.5
	WUC TOTAL	38	37	34	109	341.4

SCURAE STUDY REMUVAL ACTION DATA SUMMARY--BASE F

WEAPON SYSTEM TD OP CMND ATC
EQ NO 45
EQ FUNCTION COMM UHF
EQ IDENT WUC 63BB0 LRU 11 EQ DESCR: REC/XMTR

DATA WINDOW - 12 MONTHS
PERIOD ENDING - DEC78
PART I

----HOW MALFUNCTIONED----		----PR REMOVALS----			--TOTAL PR REMOVALS--	
CODE	NOUN	MTCH FAIL	UNMA FAIL	BCS REM	UNITS	MHRS
008	NOISY	1			1	1.0
051	FAILS TO TUNE/DRIFT	1	1	1	3	2.5
064	INCORR MODULATION	1			1	.5
070	BROKEN	2	1		3	5.6
127	ADJUSTMENT IMPROPER	1	1		2	3.3
242	FAILED TO OPERATE	1			1	2.0
622	WET/CONDENSATION		1		1	.1
693	AUDIO FAULTY	7	9	1	17	35.1
730	LOOSE		1		1	2.0
901	INTERMITTENT	5	4	2	11	18.7
962	LOW POWER	2	1		3	6.0
	WUC TOTAL	21	19	4	44	76.8

SCURAE STUDY REMOVAL ACTION DATA SUMMARY--BASE F

WEAPON SYSTEM TD OP CMND ATC
EQ NO 45
EQ FUNCTION COMM UHF
EQ IDENT WUC 63BCC LRU 02 EQ DESCR: REAR CONTROL

DATA WINDOW - 12 MONTHS
PERIOD ENDING - DEC78
PART I

----HOW MALFUNCTIONED----		----PR REMOVALS----			--TOTAL PR REMOVALS--	
CODE	NOUN	MTCH FAIL	UNMA FAIL	BCS REM	UNITS	MHRS
622	WET/CONDENSATION		1		1	.1
901	INTERMITTENT		1		1	1.0
	WUC TOTAL		2		2	1.1

SCURAE STUDY REMOVAL ACTION DATA SUMMARY--BASE F

WEAPON SYSTEM TD OP CMND ATC
EQ NO 44
EQ FUNCTION NAVIGATION
EQ IDENT WUC 71ZA0 LRU 11 EQ DESCR: REC/XMTR

DATA WINDOW - 12 MONTHS
PERIOD ENDING - DEC78
PART I

----HOW MALFUNCTIONED---- CODE	NOUN	----PR REMOVALS---- MTCH FAIL	UNMA FAIL	BCS REM	--TOTAL PR REMOVALS-- UNITS	MHRS
383	LOCK ON MALFUNCTION			2	2	5.0
658	BRG DEST STA ERROR	1		1	2	2.3
901	INTERMITTENT			1	1	2.0
	WUC TOTAL	1		4	5	9.3

SCURAE STUDY REMOVAL ACTION DATA SUMMARY--BASE F

WEAPON SYSTEM TD OP CMND ATC
EQ NO 44
EQ FUNCTION NAVIGATION
EQ IDENT WUC 71ZC0 LRU 13 EQ DESCR: MOUNT

DATA WINDOW - 12 MONTHS
PERIOD ENDING - DEC78
PART I

----HOW MALFUNCTIONED---- CODE	NOUN	----PR REMOVALS---- MTCH FAIL	UNMA FAIL	BCS REM	--TOTAL PR REMOVALS-- UNITS	MHRS
070	BROKEN		1		1	4.0
	WUC TOTAL		1		1	4.0

SCURAE STUDY REMOVAL ACTION DATA SUMMARY--BASE F

WEAPON SYSTEM TD OP CMND ATC
EQ NO 44
EQ FUNCTION NAVIGATION
EQ IDENT WUC 71ZD0 LRU 14 EQ DESCR: CONTROL

DATA WINDOW - 12 MONTHS
PERIOD ENDING - DEC78
PART I

----HOW MALFUNCTIONED----		----PR REMOVALS----			--TOTAL PR REMOVALS--	
CODE	NOUN	MTCH FAIL	UNMA FAIL	BCS REM	UNITS	MHRS
070	BROKEN		1		1	1.0
622	WET/CONDENSATION		1		1	.1
901	INTERMITTENT		1		1	2.0
	WUC TOTAL		3		3	3.1

SCURAE STUDY REMOVAL ACTION DATA SUMMARY--BASE G

WEAPON SYSTEM FB   OP CMND TAC
EQ NO 53
EQ FUNCTION IFF
EQ IDENT WUC 65AA0   LRU 11   EQ DESCR: REC/XMTR

DATA WINDOW - 12 MONTHS
PERIOD ENDING -   DEC78
PART 1

----HOW MALFUNCTIONED----		----PR REMOVALS----			--TOTAL PR REMOVALS--	
CODE	NOUN	MICH FAIL	UNMA FAIL	BCS REM	UNITS	MHRS
008	NOISY		1		1	2.0
051	FAILS TO TUNE/DRIFT	1			1	2.0
070	BROKEN	1		1	2	5.0
088	INCORRECT GAIN			1	1	1.0
242	FAILED TO OPERATE	2		2	4	12.0
255	NO/INCORR OUTPUT	12	2	1	15	42.3
290	FAILS TEST	47	23	7	78	192.7
374	INTERNAL FAILURE	1			1	2.0
472	FUSE BLOWN	1	1		2	4.5
615	SHORTED		1		1	1.0
693	AUDIO FAULTY	1		1	2	4.0
694	AUDIO & VIDEO FAULT		1		1	2.0
748	FREQ ERRATIC/INCORR	1			1	2.0
901	INTERMITTENT	3			3	8.7
944	PARITY ERROR		1		1	3.0
957	NO DISPLAY			1	1	3.0
958	INCORRECT DISPLAY		1	2	3	7.2
	WUC TOTAL	70	51	16	118	294.4

SCURAE STUDY REMOVAL ACTION DATA SUMMARY--BASE G

WEAPON SYSTEM FB OP CMND TAC — DATA WINDOW - 12 MONTHS
EQ NO 05 — PERIOD ENDING - DEC78
EQ FUNCTION RADAR FC — PART 1
EQ IDENT WUC 74F00 LRU 18 EQ DESCR: R DATA PROC

----HOW MALFUNCTIONED---- CODE	NOUN	----PR REMOVALS---- MTCH FAIL	UNMA FAIL	BCS REM	--TOTAL PR REMOVALS-- UNITS	MHRS
037	FLUCTUATES	1			1	1.0
160	DEFECTIVE CONTACT		1		1	6.0
242	FAILED TO OPERATE	2	1		3	7.0
255	NO/INCORR OUTPUT	6	2	1	9	29.8
290	FAILS TEST	78	45	71	194	492.1
374	INTERNAL FAILURE		1		1	1.5
383	LOCK ON MALFUNCTION		1	2	3	6.0
649	SWEEP MALFUNCTION	1			1	2.2
718	IMP RESP TO MECH IN			1	1	1.0
780	BENT	1	1		2	3.0
949	COMPUTER MEM ERROR		5		5	5.0
957	NO DISPLAY	3	1		4	12.8
958	INCORRECT DISPLAY	4	1	2	7	14.8
	WUC TOTAL	96	59	77	232	582.2

SCURAE STUDY REMOVAL ACTION DATA SUMMARY--BASE H

WEAPON SYSTEM FZ OP CMND TAC — DATA WINDOW - 12 MONTHS
EQ NO 44 — PERIOD ENDING - DEC78
EQ FUNCTION NAVIGATION — PART 1
EQ IDENT WUC 71ZA0 LRU 11 EQ DESCR: REC/XMTR

----HOW MALFUNCTIONED---- CODE	NOUN	----PR REMOVALS---- MTCH FAIL	UNMA FAIL	BCS REM	--TOTAL PR REMOVALS-- UNITS	MHRS
656	BRG DEST STA ERROR	1			1	3.0
	WUC TOTAL	1			1	3.0

SCURAE STUDY REMOVAL ACTION DATA SUMMARY--BASE H

WEAPON SYSTEM FZ OP CMND TAC — DATA WINDOW - 12 MONTHS
EQ NO 44 — PERIOD ENDING - DEC78
EQ FUNCTION NAVIGATION — PART I
EQ IDENT WUC 71Z80 LRU 12 EQ DESCR: D/A CONV

----HOW MALFUNCTIONED----		----PR REMOVALS----			--TOTAL PR REMOVALS--	
CODE	NOUN	MTCH FAIL	UNMA FAIL	BCS REM	UNITS	MHRS
657	DISTANCE MEAS ERROR	1	1		2	6.8
	WUC TOTAL	1	1		2	6.8

SCURAE STUDY REMOVAL ACTION DATA SUMMARY--BASE H

WEAPON SYSTEM FZ OP CMND TAC — DATA WINDOW - 12 MONTHS
EQ NO 54 — PERIOD ENDING - DEC78
EQ FUNCTION RADAR ALT — PART 1
EQ IDENT WUC 73CA0 LRU 11 EQ DESCR: REC/XMTR 771

----HOW MALFUNCTIONED----		----PR REMOVALS----			--TOTAL PR REMOVALS--	
CODE	NOUN	MTCH FAIL	UNMA FAIL	BCS REM	UNITS	MHRS
127	ADJUSTMENT IMPROPER		1		1	2.0
290	FAILS TEST	2			2	4.5
374	INTERNAL FAILURE	1	1		2	6.0
657	DISTANCE MEAS ERROR		2		3	5.0
901	INTERMITTENT	1			1	2.0
	WUC TOTAL	4	4		9	19.5

SCURAE STUDY REMOVAL ACTION DATA SUMMARY--BASE I

WEAPON SYSTEM F8   OP CMND TAC   DATA WINDOW - 12 MONTHS
EQ NO 53   PERIOD ENDING - DEC78
EQ FUNCTION IFF   PART I
EQ IDENT WUC 65AA0   LRU 11   EQ DESCR: REC/XMTR

----HOW MALFUNCTIONED---- CODE	NOUN	----PR REMOVALS---- MTCH FAIL	UNMA FAIL	BCS REM	--TOTAL PR REMOVALS-- UNITS	MHRS
242	FAILED TO OPERATE			1	1	6.3
255	NO/INCORR OUTPUT	1			1	2.0
290	FAILS TEST	6		1	7	23.0
374	INTERNAL FAILURE	2	3	2	7	22.8
	WUC TOTAL	9	3	4	16	54.1

SCURAE STUDY REMOVAL ACTION DATA SUMMARY--BASE I

WEAPON SYSTEM F8   OP CMND TAC   DATA WINDOW - 12 MONTHS
EQ NO 05   PERIOD ENDING - DEC78
EQ FUNCTION RADAR FC   PART I
EQ IDENT WUC 74F00   LRU 18   EQ DESCR: R DATA PROC

----HOW MALFUNCTIONED---- CODE	NOUN	----PR REMOVALS---- MTCH FAIL	UNMA FAIL	BCS REM	--TOTAL PR REMOVALS-- UNITS	MHRS
127	ADJUSTMENT IMPROPER		2		2	1.5
242	FAILED TO OPERATE	4	1	4	9	30.1
290	FAILS TEST	3		5	8	21.7
374	INTERNAL FAILURE	8	7	8	23	97.4
649	SWEEP MALFUNCTION		1		1	1.5
943	DATA ERROR	1			1	1.0
949	COMPUTER MEM ERROR		1		1	2.7
	WUC TOTAL	16	12	17	45	155.9

SCURAE STUDY REMOVAL ACTION DATA SUMMARY--BASE I

WEAPON SYSTEM AM OP CMND TAC
EQ NO 45
EQ FUNCTION COMM UHF
EQ IDENT WUC 63AA0 LRU 11 EQ DESCR: REC/XMTR

DATA WINDOW - 12 MONTHS
PERIOD ENDING - DEC78
PART 1

----HOW MALFUNCTIONED---- CODE	NOUN	----PR REMOVALS---- MTCH FAIL	UNMA FAIL	BCS REM	--TOTAL PR REMOVALS-- UNITS	MHRS
008	NOISY	1			1	
051	FAILS TO TUNE/DRIFT	1			1	.4
080	DEFECTIVE LAMP		1		1	1.0
255	NO/INCORR OUTPUT		2	1	3	5.8
693	AUDIO FAULTY	4	1		5	4.8
901	INTERMITTENT	1			1	.6
	WUC TOTAL	7	4	1	12	12.6

SCURAE STUDY REMOVAL ACTION DATA SUMMARY--BASE I

WEAPON SYSTEM AM OP CMND TAC
EQ NO 53
EQ FUNCTION IFF
EQ IDENT WUC 65AA0 LRU 11 EQ DESCR: REC/XMTR

DATA WINDOW - 12 MONTHS
PERIOD ENDING - DEC78
PART 1

----HOW MALFUNCTIONED---- CODE	NOUN	----PR REMOVALS---- MTCH FAIL	UNMA FAIL	BCS REM	--TOTAL PR REMOVALS-- UNITS	MHRS
135	BINDING	1			1	1.5
255	NO/INCORR OUTPUT	4	2	1	7	10.3
290	FAILS TEST		1		1	4.0
	WUC TOTAL	5	3	1	9	15.8

SCURAE STUDY REMOVAL ACTION DATA SUMMARY--BASE I

WEAPON SYSTEM AM OP CMND TAC
EQ NO 44
EQ FUNCTION NAVIGATION
EQ IDENT WUC 71ZA0 LRU 11 EQ DESCR: REC/XMTR

DATA WINDOW - 12 MONTHS
PERIOD ENDING - DEC78
PART I

----HOW MALFUNCTIONED----		----PR REMOVALS----			--TOTAL PR REMOVALS--	
CODE	NOUN	MTCH FAIL	UNMA FAIL	BCS REM	UNITS	MHRS
383	LOCK ON MALFUNCTION		1		1	.5
	WUC TOTAL		1		1	.5

SCURAE STUDY REMOVAL ACTION DATA SUMMARY--BASE I

WEAPON SYSTEM AM OP CMND TAC
EQ NO 44
EQ FUNCTION NAVIGATION
EQ IDENT WUC 71Z80 LRU 12 EQ DESCR: D/A CONV

DATA WINDOW - 12 MONTHS
PERIOD ENDING - DEC78
PART 1

----HOW MALFUNCTIONED----		----PR REMOVALS----			--TOTAL PR REMOVALS--	
CODE	NOUN	MTCH FAIL	UNMA FAIL	BCS REM	UNITS	MHRS
383	LOCK ON MALFUNCTION		1		1	.5
	WUC TOTAL		1		1	.5

SCURAE STUDY REMOVAL ACTION DATA SUMMARY--BASE I

WEAPON SYSTEM AM OP CMND TAC DATA WINDOW - 12 MONTHS
EQ NO 44 PERIOD ENDING - DEC78
EQ FUNCTION NAVIGATION PART 1
EQ IDENT WUC 71ZC0 LRU 13 EQ DESCR: MOUNT

----HOW MALFUNCTIONED----		----PR REMOVALS----			--TOTAL PR REMOVALS--	
CODE	NOUN	MTCH FAIL	UNMA FAIL	BCS REM	UNITS	MHRS
070	BROKEN	1			1	1.0
	WUC TOTAL	1			1	1.0

SCURAE STUDY REMOVAL ACTION DATA SUMMARY--BASE I

WEAPON SYSTEM AM OP CMND TAC DATA WINDOW - 12 MONTHS
EQ NO 44 PERIOD ENDING - DEC78
EQ FUNCTION NAVIGATION PART 1
EQ IDENT WUC 71Z00 LRU 14 EQ DESCR: CONTROL

----HOW MALFUNCTIONED----		----PR REMOVALS----			--TOTAL PR REMOVALS--	
CODE	NOUN	MTCH FAIL	UNMA FAIL	BCS REM	UNITS	MHRS
190	CRACKED	1			1	4.0
383	LOCK ON MALFUNCTION		1		1	.5
658	BRG DEST STA ERROR	1			1	4.0
	WUC TOTAL	2	1		3	8.5

SCURAE STUDY REMOVAL ACTION DATA SUMMARY--BASE J

WEAPON SYSTEM BA OP CMND SAC — DATA WINDOW - 12 MONTHS
EQ NO 54 — PERIOD ENDING - DEC78
EQ FUNCTION RADAR ALT — PART I
EQ IDENT WUC 73CA0 LRU 11 EQ DESCR: REC/XMTR 771

----HOW MALFUNCTIONED---- CODE	NOUN	----PR REMOVALS---- MTCH FAIL	UNMA FAIL	BCS REM	--TOTAL PR REMOVALS-- UNITS	M/HRS
037	FLUCTUATES	1	1		2	7.5
242	FAILED TO OPERATE	91	12	16	119	566.5
255	NO/INCORR OUTPUT	1			1	3.0
383	LOCK ON MALFUNCTION	1			1	6.0
615	SHORTED	1			1	1.7
	WUC TOTAL	95	13	16	124	584.7

SCURAE STUDY REMOVAL ACTION DATA SUMMARY--BASE J

WEAPON SYSTEM CL OP CMND SAC — DATA WINDOW - 12 MONTHS
EQ NO 45 — PERIOD ENDING - DEC78
EQ FUNCTION COMM UHF — PART I
EQ IDENT WUC 63RA0 LRU 11 EQ DESCR: REC/XMTR

----HOW MALFUNCTIONED---- CODE	NOUN	----PR REMOVALS---- MTCH FAIL	UNMA FAIL	BCS REM	--TOTAL PR REMOVALS-- UNITS	M/HRS
008	NOISY	1			1	2.0
255	NO/INCORR OUTPUT	2			2	5.0
693	AUDIO FAULTY	15	12		27	54.3
748	FREQ ERRATIC/INCORR		1		1	.5
901	INTERMITTENT	3	4		7	8.7
	WUC TOTAL	21	17		38	70.5

SCURAE STUDY REMOVAL ACTION DATA SUMMARY--BASE J

WEAPON SYSTEM CL   OP CMND SAC   DATA WINDOW - 12 MONTHS
EQ NO 45   PERIOD ENDING -   DEC78
EQ FUNCTION COMM UHF   PART I
EQ IDENT WUC 63RB0   LRU 12   EQ DESCR: CONTROL

----HOW MALFUNCTIONED---- CODE	NOUN	----PR REMOVALS---- MTCH FAIL	UNMA FAIL	BCS REM	--TOTAL PR REMOVALS-- UNITS	M/HRS
070	BROKEN	1	2		3	6.0
693	AUDIO FAULTY	5	4		9	22.3
748	FREQ ERRATIC/INCORR		1		1	1.0
901	INTERMITTENT	2	2	1	5	8.8
	WUC TOTAL	8	9	1	18	38.1

SCURAE STUDY REMOVAL ACTION DATA SUMMARY--BASE J

WEAPON SYSTEM CL   OP CMND SAC   DATA WINDOW - 12 MONTHS
EQ NO 44   PERIOD ENDING -   DEC78
EQ FUNCTION NAVIGATION   PART I
EQ IDENT WUC 71ZA0   LRU 11   EQ DESCR: REC/XMTR

----HOW MALFUNCTIONED---- CODE	NOUN	----PR REMOVALS---- MTCH FAIL	UNMA FAIL	BCS REM	--TOTAL PR REMOVALS-- UNITS	M/HRS
255	NO/INCORR OUTPUT	1			1	4.0
383	LOCK ON MALFUNCTION	1			1	4.3
657	DISTANCE MEAS ERROR			1	1	1.5
	WUC TOTAL	2		1	3	9.8

SCURAE STUDY REMOVAL ACTION DATA SUMMARY--BASE J

WEAPON SYSTEM CL OP CMND SAC — DATA WINDOW - 12 MONTHS
EQ NO 44 — PERIOD ENDING - DEC78
EQ FUNCTION NAVIGATION — PART I
EQ IDENT WUC 71Z80 LRU 12 EQ DESCR: D/A CONV

----HOW MALFUNCTIONED---- CODE	NOUN	----PR REMOVALS---- MTCH FAIL	UNMA FAIL	BCS REM	--TOTAL PR REMOVALS-- UNITS	M/HRS
255	NO/INCORR OUTPUT		1	1	2	6.0
383	LOCK ON MALFUNCTION	1			1	4.0
657	DISTANCE MEAS ERROR			2	2	4.8
	WUC TOTAL	1	1	3	5	14.8

SCURAE STUDY REMOVAL ACTION DATA SUMMARY--BASE J

WEAPON SYSTEM CL OP CMND SAC — DATA WINDOW - 12 MONTHS
EQ NO 44 — PERIOD ENDING - DEC78
EQ FUNCTION NAVIGATION — PART I
EQ IDENT WUC 71ZC0 LRU 13 EQ DESCR: MOUNT

----HOW MALFUNCTIONED---- CODE	NOUN	----PR REMOVALS---- MTCH FAIL	UNMA FAIL	BCS REM	--TOTAL PR REMOVALS-- UNITS	M/HRS
255	NO/INCORR OUTPUT		1		1	3.0
	WUC TOTAL		1		1	3.0

SCURAE STUDY REMOVAL ACTION DATA SUMMARY--BASE K

WEAPON SYSTEM TD OP CMND ATC
EQ NO 45
EQ FUNCTION COMM UHF
EQ IDENT WUC 63BB0 LRU 11 EQ DESCR: REC/XMTR

DATA WINDOW - 12 MONTHS
PERIOD ENDING - DEC78
PART I

----HOW MALFUNCTIONED---- CODE	NOUN	----PR REMOVALS---- MTCH FAIL	UNMA FAIL	BCS REM	--TOTAL PR REMOVALS-- UNITS	MHRS
051	FAILS TO TUNE/DRIFT	2	1		3	5.3
127	ADJUSTMENT IMPROPER		1		1	1.0
242	FAILED TO OPERATE		2		2	4.0
255	NO/INCURR OUTPUT	8	6	1	15	18.7
635	SENS. INCORRECT			1	1	.3
693	AUDIO FAULTY	5	3	1	9	12.2
748	FREQ ERRATIC/INCORR		1		1	1.0
901	INTERMITTENT		1		1	1.7
	WUC TOTAL	15	15	3	33	44.2

SCURAE STUDY REMOVAL ACTION DATA SUMMARY--BASE K

WEAPON SYSTEM TD OP CMND ATC — DATA WINDOW - 12 MONTHS
EQ NO 44 — PERIOD ENDING - DEC78
EQ FUNCTION NAVIGATION — PART I
EQ IDENT WUC 712A0 LRU 11 EQ DESCR: REC/XMTR

----HOW MALFUNCTIONED---- CODE	NOUN	----PR REMOVALS---- MTCH FAIL	UNMA FAIL	BCS REM	--TOTAL PR REMOVALS-- UNITS	MHRS
037	FLUCTUATES	1		1	2	3.0
255	NO/INCORR OUTPUT	8	3	2	13	21.7
383	LOCK ON MALFUNCTION	4	1		5	7.8
657	DISTANCE MEAS ERROR			4	4	3.8
658	BRG DEST STA ERROR	2			2	2.8
901	INTERMITTENT	2		2	4	4.0
962	LOW POWER	3			3	4.5
	WUC TOTAL	20	4	9	33	47.6

SCURAE STUDY REMOVAL ACTION DATA SUMMARY--BASE K

WEAPON SYSTEM TD OP CMND ATC
EQ NO 44
EQ FUNCTION NAVIGATION
EQ IDENT WUC 71Z80 LRU 12 EQ DESCR: D/A CONV

DATA WINDOW - 12 MONTHS
PERIOD ENDING - DEC78
PART I

----HOW MALFUNCTIONED----		----PR REMOVALS----			--TOTAL PR REMOVALS--	
CODE	NOUN	MTCH FAIL	UNMA FAIL	BCS REM	UNITS	MHRS
037	FLUCTUATES			1	1	.5
255	NO/INCORR OUTPUT			7	7	7.1
383	LOCK ON MALFUNCTION			2	2	1.1
657	DISTANCE MEAS ERROR			3	3	2.2
658	BRG DEST STA ERROR			1	1	1.0
901	INTERMITTENT		1	1	2	1.8
	WUC TOTAL		1	15	16	13.7

SCURAE STUDY REMOVAL ACTION DATA SUMMARY--BASE K

WEAPON SYSTEM TD OP CMND ATC
EQ NO 44
EQ FUNCTION NAVIGATION
EQ IDENT WUC 71ZC0 LRU 13 EQ DESCR: MOUNT

DATA WINDOW - 12 MONTHS
PERIOD ENDING - DEC78
PART I

----HOW MALFUNCTIONED----		----PR REMOVALS----			--TOTAL PR REMOVALS--	
CODE	NOUN	MTCH FAIL	UNMA FAIL	BCS REM	UNITS	MHRS
037	FLUCTUATES			1	1	.5
255	NO/INCORR OUTPUT	1	1	6	8	12.4
383	LOCK ON MALFUNCTION			3	3	2.1
657	DISTANCE MEAS ERROR			3	3	3.2
658	BRG DEST STA ERROR			1	1	1.0
901	INTERMITTENT		1	1	2	1.8
	WUC TOTAL	1	2	15	18	21.0

SCURAE STUDY REMOVAL ACTION DATA SUMMARY--BASE K

WEAPON SYSTEM TD OP CMND AIC   DATA WINDOW - 12 MONTHS
EQ NO 44   PERIOD ENDING - DEC78
EQ FUNCTION NAVIGATION   PART I
EQ IDENT WUC 71Z00 LRU 14 EQ DESCR: CONTROL

----HOW MALFUNCTIONED---- CODE	NOUN	----PR REMOVALS---- MTCH FAIL	UNMA FAIL	BCS REM	--TOTAL PR REMOVALS-- UNITS	MHRS
070	BROKEN	1			1	1.0
080	DEFECTIVE LAMP			1	1	1.3
135	BINDING	1			1	1.0
255	NO/INCORR OUTPUT	2			2	3.5
	WUC TOTAL	4		1	5	6.8

SCURAE STUDY REMOVAL ACTION DATA SUMMARY--BASE L

WEAPON SYSTEM TD OP CMND AIC   DATA WINDOW - 12 MONTHS
EQ NO 45   PERIOD ENDING - DEC78
EQ FUNCTION COMM UHF   PART I
EQ IDENT WUC 63BB0 LRU 11 EQ DESCR: REC/XMTR

----HOW MALFUNCTIONED---- CODE	NOUN	----PR REMOVALS---- MTCH FAIL	UNMA FAIL	BCS REM	--TOTAL PR REMOVALS-- UNITS	MHRS
008	NOISY	1	1		2	.8
051	FAILS TO TUNE/DRIFT	1			1	1.2
080	DEFECTIVE LAMP			1	1	1.5
255	NO/INCORR OUTPUT	7	2	3	12	11.7
472	FUSE BLOWN	2			2	2.5
635	SENS. INCORRECT	1			1	.5
693	AUDIO FAULTY	7	2	2	11	14.7
748	FREQ ERRATIC/INCORR	2			2	2.5
901	INTERMITTENT	1	1	4	6	13.5
	WUC TOTAL	22	6	10	38	48.9

SCURAE STUDY REMOVAL ACTION DATA SUMMARY--BASE L

WEAPON SYSTEM TD OP CMND ATC — DATA WINDOW - 12 MONTHS
EQ NO 45 — PERIOD ENDING - DEC78
EQ FUNCTION COMM UHF — PART 1
EQ IDENT WUC 63BCC LRU 02 EQ DESCR: REAR CONTROL

----HOW MALFUNCTIONED---- CODE	NOUN	----PR REMOVALS---- MTCH FAIL	UNMA FAIL	BCS REM	--TOTAL PR REMOVALS-- UNITS	MHRS
070	BROKEN	1			1	1.5
255	NO/INCURR OUTPUT		1		1	1.2
901	INTERMITTENT		1		1	1.0
	WUC TOTAL	1	2		3	3.7

SCURAE STUDY REMOVAL ACTION DATA SUMMARY--BASE L

WEAPON SYSTEM TD OP CMND ATC — DATA WINDOW - 12 MONTHS
EQ NO 44 — PERIOD ENDING - DEC78
EQ FUNCTION NAVIGATION — PART 1
EQ IDENT WUC 71ZA0 LRU 11 EQ DESCR: REC/XMTR

----HOW MALFUNCTIONED---- CODE	NOUN	----PR REMOVALS---- MTCH FAIL	UNMA FAIL	BCS REM	--TOTAL PR REMOVALS-- UNITS	MHRS
242	FAILED TO OPERATE	1			1	2.0
255	NO/INCURR OUTPUT	4		1	5	10.4
635	SENS. INCORRECT	1			1	3.0
657	DISTANCE MEAS ERROR	1	1		2	4.5
658	BRG DEST STA ERROR	1			1	.7
901	INTERMITTENT	2			2	1.3
957	NO DISPLAY	1			1	2.5
	WUC TOTAL	11	1	1	13	24.4

SCURAE STUDY REMOVAL ACTION DATA SUMMARY--BASE L

WEAPON SYSTEM TD OP CMND ATC — DATA WINDOW - 12 MONTHS
EQ NO 44 — PERIOD ENDING - DEC78
EQ FUNCTION NAVIGATION — PART I
EQ IDENT WUC 71Z80 LRU 12 EQ DESCR: D/A CONV

----HOW MALFUNCTIONED----		----PR REMOVALS----			--TOTAL PR REMOVALS--	
CODE	NOUN	MTCH FAIL	UNMA FAIL	BCS REM	UNITS	MHRS
255	NO/INCORR OUTPUT	1			1	1.0
657	DISTANCE MEAS ERROR			1	1	3.0
901	INTERMITTENT	1			1	3.7
	WUC TOTAL	2		1	3	7.7

SCURAE STUDY REMOVAL ACTION DATA SUMMARY--BASE L

WEAPON SYSTEM TD OP CMND ATC — DATA WINDOW - 12 MONTHS
EQ NO 44 — PERIOD ENDING - DEC78
EQ FUNCTION NAVIGATION — PART I
EQ IDENT WUC 71ZC0 LRU 13 EQ DESCR: MOUNT

----HOW MALFUNCTIONED----		----PR REMOVALS----			--TOTAL PR REMOVALS--	
CODE	NOUN	MTCH FAIL	UNMA FAIL	BCS REM	UNITS	MHRS
658	BRG DEST STA ERROR	1			1	3.0
901	INTERMITTENT	1			1	2.0
	WUC TOTAL	2			2	5.0

SCURAE STUDY REMOVAL ACTION DATA SUMMARY--BASE L

WEAPON SYSTEM TD OP CMND ATC
EQ NO 44 DATA WINDOW - 12 MONTHS
EQ FUNCTION NAVIGATION PERIOD ENDING - DEC78
EQ IDENT WUC 71Z00 LRU 14 EQ DESCR: CONTROL PART I

----HOW MALFUNCTIONED---- CODE	NOUN	----PR REMOVALS---- MTCH FAIL	UNMA FAIL	BCS REM	--TOTAL PR REMOVALS-- UNITS	MHRS
070	BROKEN	4		1	5	2.6
255	NO/INCORR OUTPUT	2	1	3	6	6.3
901	INTERMITTENT			1	1	1.2
	WUC TOTAL	6	1	5	12	10.1

(Page C-38 Blank)

APPENDIX D

WORK UNIT CODE DATA

NOTE:

WUCs ending in "ZZ" are Hughes designations which include related, specific LRUs deemed to constitute an equipment.

AIRCRAFT	EQUIP	LRU	WUC
B-52 *	ARC-164	R/T	63EA0
B-52 *	ARC-164	CNTRL	63EBA
B-52 *	ARC-164	ALL	63EZZ
B-52 *	ARN-118	R/T	71ZA0
B-52 *	ARN-118	CONV	71ZB0
B-52 *	ARN-118	MOUNT	71ZC0
B-52 *	ARN-118	CNTRL	71ZD0
B-52 *	ARN-118	ALL	71ZZZ
FB-111A	APN-167	R/T	73CA0
FB-111A	APN-167	MOUNT	73CAK
FB-111A	APN-167	INDIC	73CAP
FB-111A	APN-167	ALL	73CZZ
F-15A	APX-101	R/T	65AA0
F-15A	APG-63	081	74F00
F-15A	APG-63	ALL	74FZZ
T-38	ARC-164	R/T	63BB0
T-38	ARC-164	ALL	63BZZ
T-38	ARN-118	R/T	71ZA0
T-38	ARN-118	CONV	71ZB0
T-38	ARN-118	MOUNT	71ZC0
T-38	ARN-118	CNTRL	71ZD0
T-38	ARN-118	ALL	71ZZZ
F-101	ARC-164	R/T	6321A
F-101	ARC-164	CNTRL	6321S
F-101	ARC-164	ALL	632ZZ
F-111F	APN-167	R/T	73CA0
F-111F	APN-167	MOUNT	73CAK
F-111F	APN-167	INDIC	73CAP
F-111F	APN-167	ALL	73CZZ
KC-135A	ARC-164	R/T	63RA0
KC-135A	ARC-164	CNTRL	63RB0
KC-135A	ARC-164	ALL	63RZZ
KC-135A	ARN-118	R/T	71ZA0
KC-135A	ARN-118	CONV	71ZB0
KC-135A	ARN-118	MOUNT	71ZC0
KC-135A	ARN-118	CNTRL	71ZD0
KC-135A	ARN-118	ALL	71ZZZ
A-10A	ARC-164	R/T	63AA0
A-10A	ARC-164	ALL	63AZZ
A-10A	APX-101	R/T	65AA0
A-10A	ARN-118	R/T	71ZA0
A-10A	ARN-118	CONV	71ZB0
A-10A	ARN-118	MOUNT	71ZC0
A-10A	ARN-118	CNTRL	71ZD0
A-10A	ARN-118	ALL	71ZZZ
F-111D	APN-167	R/T	73CA0
F-111D	APN-167	MOUNT	73CAK
F-111D	APN-167	INDIC	73CAP
F-111D	APN-167	ALL	73CZZ
C-130 *	ARC-164	R/T	63AA0

AIRCRAFT	EQUIP	LRU	WUC
C-130 *	ARC-164	CNTRL	63AF0
C-130 *	ARC-164	ALL	63AZZ
C-130 *	ARN-118	R/T	71ZA0
C-130 *	ARN-118	CONV	71ZB0
C-130 *	ARN-118	MOUNT	71ZC0
C-130 *	ARN-118	CNTRL	71ZD0
C-130 *	ARN-118	ALL	71ZZZ
A-7D	ARC-164	R/T	63CA0
A-7D	ARC-164	CNTRL	63CB0
A-7D	ARC-164	INDIC	63CC0
A-7D	ARC-164	ALL	63CZZ
A-7D	ARN-118	R/T	71ZA0
A-7D	ARN-118	CONV	71ZB0
A-7D	ARN-118	MOUNT	71ZC0
A-7D	ARN-118	CNTRL	71ZD0
A-7D	ARN-118	ALL	71ZZZ
A-7D	ASN-90	IMU	73FA0
A-7D	ASN-90	CNTRL	73FC0
A-7D	ASN-90	P/S AD	73FD0
A-7D	ASN-90	ALL	73FZZ
C-141	ARN-118	R/T	71ZA0
C-141	ARN-118	CONV	71ZB0
C-141	ARN-118	MOUNT	71ZC0
C-141	ARN-118	CNTRL	71ZD0
C-141	ARN-118	ALL	71ZZZ
T-37	ARC-164	R/T	633A0
T-37	ARC-164	ALL	633ZZ
F-111 *	ARN-118	R/T	71ZA0
F-111 *	ARN-118	CONV	71ZB0
F-111 *	ARN-118	MOUNT	71ZC0
F-111 *	ARN-118	CNTRL	71ZD0
F-111 *	ARN-118	ALL	71ZZZ
F-111**	APN-167	R/T	73CA0
F-111**	APN-167	MOUNT	73CAK
F-111**	APN-167	INDIC	73CAP
F-111**	APN-167	ALL	73CZZ
T-39	ARC-164	R/T	6321A
T-39	ARC-164	CNTRL	6321N
T-39	ARC-164	ALL	632ZZ
T-39	ARN-118	R/T	71ZA0
T-39	ARN-118	CONV	71ZB0
T-39	ARN-118	MOUNT	71ZC0
T-39	ARN-118	CNTRL	71ZD0
T-39	ARN-118	ALL	71ZZZ
F-111A	APN-167	R/T	73CA0
F-111A	APN-167	MOUNT	73CAK
F-111A	APN-167	INDIC	73CAP
F-111A	APN-167	ALL	73CZZ
F-111E	APN-167	R/T	73CA0
F-111E	APN-167	MOUNT	73CAK
F-111F	APN-167	INDIC	73CAP
F-111E	APN-167	ALL	73CZZ

APPENDIX E

AIR FORCE DOCUMENTS

(Excerpts)

EXCERPTS

AFLC/AFSC P 400-11

Chapter 9

MAINTENANCE EXPERIENCE DATA (AFM 66-1)

9-1. PURPOSE. The purpose of this chapter is to outline the Maintenance Data Collection (MDC) system established by AFR 66-14 and AFM 66-1. The MDC is the primary source for Air Force reliability and maintainability data; therefore, basic understanding of its objectives, uses, and limitations is essential to R&M data users.

9-4. DOCUMENTATION CONCEPT. The AFTO Forms 346, 349, and 350 are used as source documents for the maintenance data collection system.

a. Recording Concept procedures are divided into two basic categories identified as on-equipment and off-equipment maintenance documentation.

(1) Maintenance actions accomplished on complete end items of equipment (aircraft, missiles, removed engines, ground communications-electronics-meteorological (CEM), trainers, Aerospace Ground Equipment (AGE) and nuclear weapons) are identified as on-equipment work. This primarily consists of support general tasks, inspections, removal and replacement of components, fix-in-place maintenance actions, and modifications.

(2) In-shop maintenance actions involving intermediate level maintenance on removed components is identified as off-equipment maintenance. This primarily consists of bench check, repair or modification of components and assemblies, and nondestructive inspection.

(3) If maintenance is done on components that are removed or removed and replaced to facilitate maintenance in the same room or one immediately adjacent to the end item; this is recorded as on-equipment maintenance. If the individual that removed the component has to leave the immediate area (defined as out-of-sight), an AFTP Form 350 will be prepared to identify the status of the removed component. In this regard, when personnel from one workcenter remove an item and send it to personnel with a different workcenter code for maintenance, the latter workcenter will record it as off-equipment maintenance.

b. Data Forms:

(1) Use of the AFTO Form 349. The AFTO Form 349, "Maintenance Data Collection Record," was designed with sufficient flexibility for use by the majority of organizations in recording maintenance actions on various types of equipment. Recording and data collection procedures pertaining to this form are outlined in the 00-20-2-series technical orders.

(a) For on-equipment work the primary entries required on the AFTO Form 349 are block 1 (Job Control Number), block 2 (Workcenter), block 3 (ID Number), block 6 (Time, as applicable), and columns B through K. For in-shop engine work, primary entries are required in blocks 1 and 2, block 3 (Engine ID) and in columns B through K. For off-equipment work on removed components, primary entries are required in blocks 1, 2, and block 3 or 5; block 19 (Federal Supply Class (FSC)), block 20 (Part Number), and columns B through K.

(c) The AFTO Form 349 can be used for identification of both the end item of equipment and a component for engine change actions, for weapon systems and equipment that are managed under the Advanced Configuration Management System (ACMS), for time change items, for special reporting on tires, and for reporting off-equipment maintenance actions.

(2) Use of the AFTO Form 350. The AFTO Form 350, "Reparable Item Processing Tag," is a two-part perforated form that is attached to components that are removed from equipment end items and serves as an identification and status tag. Another important aspect of this form is that it serves as a source document pertaining to Repaired This Station (RTS), Not Repaired This Station (NRTS), and condemnation actions for the supply system. This information is input to the base supply computer to identify stockage requirements. Information pertaining to RTS, NRTS, and condemnations is also forwarded through the supply system to AFLC as factors for computing the world-wide spares requirements. Recording procedures for the AFTO Form 350 are outlined in the 00-20-2-series technical orders.

c. Data Elements:

(1) Job Control Number (JCN). The JCN consists of seven characters, the first three are the julian date and the last four are a unique job number for that date. This provides a means to tie together all on- and off-equipment actions taken, man-hours expended, and parts consumed to satisfy a maintenance requirement whether it be a discrepancy, an inspection, or a TCTO. Every action taken that is related to a job, regardless of workcenter, time, or place, will carry the same job control number that was originally assigned to the job. This procedure is necessary to permit control of all related actions, and to provide the capability to tie them together in data systems to identify the total job for analysis purposes.

(6) Work Unit Code. The work unit code consists of five characters, and is used to identify the system, subsystem, and component on which maintenance is required or on which maintenance was accomplished. These codes are published in work unit code manuals for each weapon and support system

and in code manuals by type of equipment for selected ground CEM, trainers, AGE, munitions, PME, and shop work. The first two positions of the work unit codes for aircraft, ground radar, and missiles are standard system codes. They identify functional systems such as flight control system, codes antenna system, or launch control system. The first two positions of the work unit codes for support equipment identify types of equipment, such as ground powered generators, or end items of equipment, such as a trainer. The third and fourth positions of the work unit code identify subsystem or major assembly. The fifth position of the work unit code normally identifies reparable items.

(8) Action Taken Code. The action taken code consists of one character used to identify the maintenance action that was taken, such as remove and replace. Action taken codes are standard for all equipment and are listed in all work unit code manuals. A complete list of authorized action taken codes is contained in AFM 300-4, volume XI.

(9) When Discovered Code. The when discovered code consists of one character and is used to identify when a defect or maintenance requirement was discovered, such as during a quality control inspection. When discovered codes are listed in each work unit code manual for individual types of equipment. A complete list of authorized when discovered codes is contained in AFM 300-4, volume XI. Only that portion of the when discovered code definition that applies to equipment listed in the work unit code manual is to be used. For example, when discovered code D, In-Flight-No-Abort/ During AGE Operation, would be listed in the AGE work unit code manual as D, During AGE Operation.

(10) How Malfunctioned Code. The how malfunctioned code consists of three characters and is used to identify how the equipment malfunctioned, such as cracked. To provide maximum utility, these codes are also used to identify time compliance technical order status requirements, or to show that a maintenance action did not result from a defect. A complete list of authorized how malfunctioned codes is contained in AFM 300-4, volume XI, in both alphabetical (definition) and numerical (code) sequence.

9-5. The foregoing paragraphs of this chapter describe the MDCS objectives and reporting concept as related to the base maintenance environment. In order to provide AFLC data on maintenance events as they occur worldwide, most of the data documented at AF bases under the TO 00-20-2 series are submitted to HQ AFLC for use in logistic support and related engineering decisions. These data are received and processed centrally at HQ AFLC in the DO56 Product Performance System.

9-6. Definitions of R and M parameters and terms used in the DO56 data system:

a. Type How Malfunctioned Codes.

(1) Type 1 — These codes indicate that the item no longer can meet the minimum specified performance requirement due to its own internal failure pattern.

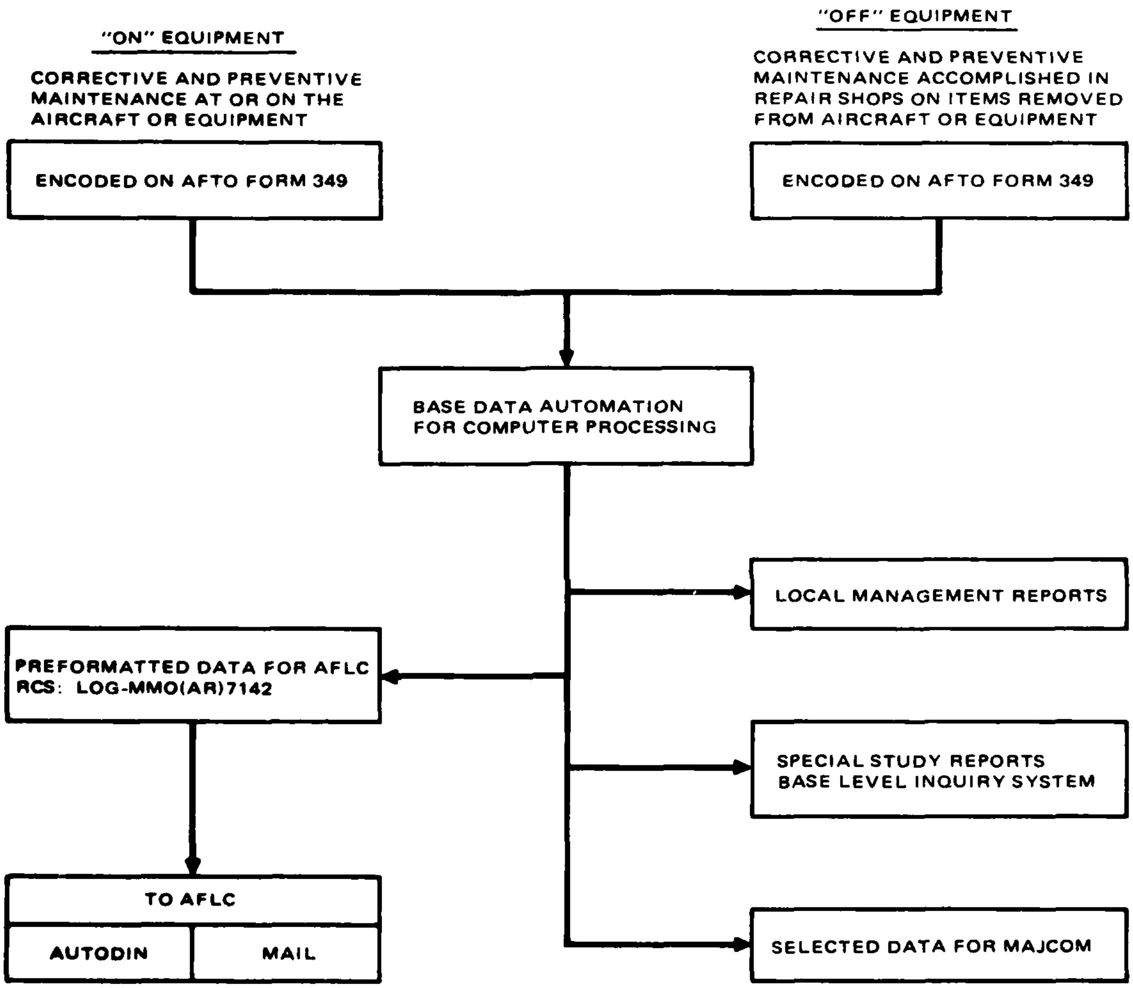
(2) Type 2 — These codes indicate that the item can no longer meet the specified performance requirement due to some induced condition and not due to its own internal failure pattern.

(3) Type 6 — These codes indicate maintenance resources were expended due to policy, modifications, items location, cannibalization and other no defect conditions existing at the time maintenance was accomplished.

AFLC/AFSC P 400-11

MAINTENANCE DATA COLLECTION SYSTEM

REPORTING AT AF BASES



ACTION TAKEN CODES

Code	Description
A	Bench Checked and Repaired This code will be entered when bench check and repair of any one item is accomplished at the same time. (Also see Code F.)
B	Bench Checked-Serviceable (No Repair Required) This code will be entered when the item is bench checked and no repair was required.
C	Bench Checked-Repair Deferred This code will be entered when bench check is accomplished and repair action is deferred. (See Code F.)
D	Bench Checked-Transferred to Another Base or Unit Item is bench checked at a forward operating base, dispersed operating base or enroute base and is found unserviceable and transferred to a main operating base or home base for repair. This code will not be used for items returned to a depot for overhaul. This code will also be used when PME or other equipment is sent to another base or unit for bench check, calibration, or repair and is to be returned, and for items forwarded to contractors on base level contracts.
1	Bench Checked-NRTS (Not Repairable This Station - Repair Not Authorized) This code will be entered when the shop is not authorized to accomplish the repair. This code shall only be used when the repair required to return an item to serviceable status is specifically prohibited by current technical directives. This code shall not be used due to lack of authority for equipment, tools, facilities, skills, parts, of technical data.
2	Bench Checked-NRTS - Lack of Equipment, Tools or Facilities This code will be entered when the repair is authorized but cannot be accomplished due to lack of equipment, tools, or facilities. This code shall be used without regard as to whether the equipment, tools, or facilities are authorized or unauthorized.
3	Bench Checked-NRTS - Lack of Technical Skills This code will be entered when repair cannot be accomplished due to lack of technically qualified people.

ACTION TAKEN CODES (Continued)

Code	Description
4	Bench Checked-NRTS - Lack of Parts This code will be entered when parts are not available to accomplish repair.
5	Bench Checked-NRTS - Shop Backlog This code will be entered when repair cannot be accomplished due to excessive shop backlog.
6	Bench Checked-NRTS - Lack of Technical Data This code will be entered when repair cannot be accomplished due to lack of maintenance manuals, drawings, etc., which describe detailed repair procedures and requirements.
7	Bench Checked-NRTS - Excess to Base Requirements This code will be entered when repair will not be scheduled for shop repair due to item being excess to base requirements.
8	Bench Checked-Returned to Depot Returned to depot by direction of System Manager (SM) or Item Manager (IM). Use only when items that are authorized for base level repair are directed to be returned to depot facilities by specific written or verbal communication from the IM or SM; or when items are to be returned to depot facilities for modification in accordance with a time compliance technical order (TCTO); or as UR exhibits.
9	Bench Checked-Condemned This code will be entered when the item cannot be repaired and is to be processed for condemnation, reclamation, or salvage. This code will also be used when a "condemned" condition is discovered during field maintenance disassembly or repair.
E	Initial Installation This code will be used for installation actions that are not related to a previous removal action such as installation of additional equipment or installation of an item to remedy a ship-short condition. This code will be used only for equipment managed under the advance configuration management system. Reference T.O.s 00-20-2-3, 00-20-2-5, and 00-20-2-7. Must be used with How Mal Code 799.

Code	Description
F	Repair This code will not be used to code "on-equipment" work if another code will apply. When it is used in a shop environment, this code will denote repair as a separate unit of work after a bench check. Shop repair includes the total repair man-hours and includes cleaning, disassembly, inspection, adjustment, reassembly and lubrication of minor components incident to the repair when these services are performed by the same work center. For precision equipment, this code will be used only when calibration of the repaired item is required (see Code G).
G	Repair and/or Replacement of Minor Parts, Hardware and Softgoods (Seals, gaskets, electrical connectors, fittings, tubing, hose, wiring, fasteners, vibration isolators, brackets, etc.) Work unit codes do not cover most non-repairable items, therefore, when items such as those identified above are repaired or replaced, this action taken code will be used. When this action taken code is used, the work unit code will identify the assembly being serviced or most directly related to parts being repaired or replaced. For example, if an electrical connector was repaired and was attached to a radio transmitter, the work unit code for the transmitter would be used with this action taken code. For precision measurement equipment this code will be used for repairs that do not require calibration of the repaired item (see Code F).
H	Equipment Checked-No Repair Required (for "On-Equipment" Work Only) This code will be used for all discrepancies which are checked and found to require no further maintenance action. This code will be used only if it is definitely determined that a reported deficiency does not exist or cannot be duplicated. Must be used with How Mal Code 799, 812, or 948.
J	Calibrated-No Adjustment Required Use this code when an item is calibrated and found serviceable without need for adjustment, or is found to be in tolerance but is adjusted merely to peak or maximize the reading. If the item requires adjustment to actually meet calibration standards or to bring in tolerance, use Code K.

ACTION TAKEN CODES (Continued)

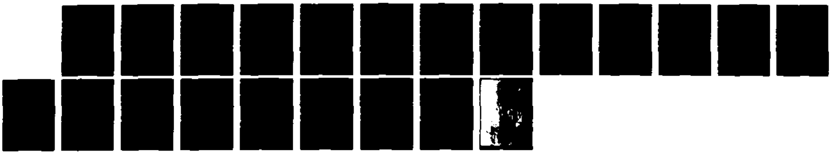
Code	Description
K	Calibrated-Adjustment Required Use this code when an item must be adjusted to bring it in tolerance or meet calibration standards. If the item was repaired or needs repair in addition to calibration and adjustment, use Code F.
L	Adjust Includes adjustments necessary for safety and proper functioning of equipment such as adjust, bleed, balance, rig, fit, reroute, seat/reseat, position/reposition, or actuating reset button, switch or circuit breaker, for use when a discrepancy or condition is corrected by these types of actions. If the identified component or assembly also requires replacement of bits and pieces as well as adjustment, enter the appropriate repair action taken code instead of L.
M	Disassemble This code will be entered for disassembly action when the complete maintenance job is broken into parts and reported as such. Do not use for on equipment work.
N	Assemble This code will be entered for assembly action when the complete maintenance job is broken into parts and reported as such. Do not use for on-equipment work.
P	Removed This code will be entered when an item is removed and only the removal is to be accounted for. In this instance delayed or additional actions will be accounted for separately. (Also see Codes Q, R, S, T, and U.) Do not use for off-equipment work.
Q	Installed This code will be entered when an item is installed and only the installation action is to be accounted for. (Also see Codes E, F, R, S, T, and U.) Do not use for off-equipment work.
R	Remove and Replace This code will be entered when an item is removed and another like item is installed. (Also see Codes T and U.) Do not use for off-equipment work.

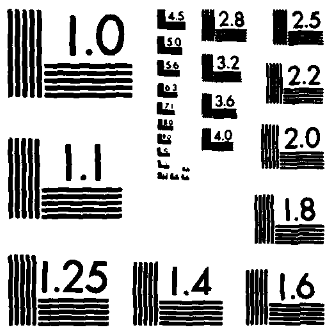
ACTION TAKEN CODES (Continued)

Code	Description
S	Remove and Reinstall This code will be entered when an item is removed and the same item reinstalled. (Also see Codes T and U.) Do not use for off-equipment work. Must be used with How Mal Code 800, 804 or 805.
T	Removed for Cannibalization This code will be entered when a component is cannibalized. The work unit code will identify the component being cannibalized. Do not use this code for off-equipment work. Must be used with How Mal Code 799.
U	Replaced after Cannibalization This code will be entered when a component is replaced after cannibalization. Do not use this code for off-equipment work. Must be used with How Mal Code 799.
V	Clean This code will be entered when cleaning is accomplished to correct discrepancy and/or when cleaning is not accounted for as part of a repair action such as Code F. Includes washing, acid bath, buffing, sand blasting, degreasing, decontamination, etc. Cleaning and washing of complete items such as ground equipment, vehicles, missiles or airplanes should be recorded by utilizing support general codes.
X	Test-Inspection-Service This code will be entered when an item is tested or inspected or serviced (other than bench check) and no repair is required. This code does not include servicing or inspection chargeable to support general work unit codes.
Y	Troubleshoot Enter this code when the time expended in locating a discrepancy is great enough to warrant separating the troubleshoot time from the repair time. Use of this code necessitates completion of two separate line entries, or two separate forms, one for the troubleshoot phase and one for the repair phase. When recording the troubleshoot time separate from the repair time, the total time taken to isolate the primary cause of the discrepancy should be recorded utilizing the work unit code of the defective subsystem or system. Do not use for off-equipment work.

AD-A127 546 STUDY OF THE CAUSES OF UNNECESSARY REMOVALS OF AVIONIC EQUIPMENT..(U) HUGHES AIRCRAFT CO EL SEGUNDO CA ELECTRO-OPTICAL AND DATA SYS.. H D RUE ET AL. JAN 83 3/3

UNCLASSIFIED HAC-FR-80-70-1135R3 RADC-TR-83-2 F/G 5/1 NL





MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

ACTION TAKEN CODES (Continued)

Code	Description
Z	Corrosion Repair Includes cleaning, treating, priming and painting of corroded items. This code should always be used when actually treating corroded items, either on equipment or in the shop. The work unit code should identify the item that is corroded. Use support general code for painting or corrosion preventive treatment prior to an item becoming corroded.

TYPE MAINTENANCE CODES

Code	Description
	Type Maintenance Codes for aircraft, drones, installed engines and related mobile training sets (MTS) and resident training equipment (RTE). Engine shop codes are included following this list of codes.
A	Service Includes all units of work associated with servicing, cleaning, and movement of equipment.
B	Unscheduled Maintenance Includes all units of work accomplished between scheduled inspections except as provided in preceding Code A, and excluding accomplishments of TCTOs.
C	Basic Postflight or Thruflight Inspection Includes all units of work accomplished during all phases of the basic postflight or thruflight inspection.
D	Preflight Inspection Includes all units of work accomplished during all phases of a preflight inspection. For mobile training sets and resident training equipment this includes all units of work accomplished during scheduled inspections such as daily, safety, and servicing inspection, excluding periodic inspections.
J	Calibration of Operational Equipment (non PME) by Owning or Assisting Work Center Excludes calibration actions by PME calibrating work centers (see T. O. 00-25-06-4-1 for type maintenance codes for PME).
P	Periodic, Phased or Major Inspection Includes all units of work accomplished during look and fix phases of periodic, phased or major inspections, excluding accomplishment of TCTOs.
Q	Forward Support Spares Includes all units of work performed by all activities in recording in-shop maintenance actions on MAC forward support spares, excluding accomplishment of TCTOs.

TYPE MAINTENANCE CODES (Continued)

Code	Description
R	Depot Maintenance Includes all units of work accomplished when depot maintenance or rehabilitation is performed, regardless of location, excludes accomplishment of TCTOs.
S	Special Inspection Includes all units of work accomplished during all phases of special inspections, excluding accomplishment of TCTOs. Includes all functional check flights.
T	Time Compliance Technical Order (TCTO) Includes accomplishment of all TCTOs.
Y	Aircraft Transient Maintenance Includes all units of work accomplished and/or for transient aircraft, excluding accomplishment of TCTOs.

HOW MALFUNCTIONED CODES — NUMERICAL LISTING (Excerpts)

008	Noisy
037	Fluctuates, Unstable or Erratic
051	Fails to Tune or Drifts
064	Incorrect Modulation
070	Broken
080	Burned Out or Defective Lamp, Meter or Indicating Device
088	Incorrect Gate
103	Attack Display Malfunction
127	Adjustment or Alignment Improper
135	Binding, Stuck or Jammed
160	Contacts/Connection Defective
169	Incorrect Voltage
190	Cracked
242	Failed to Operate or Function — Specific Reason Unknown
255	No Output/Incorrect Output
290	Fails Diagnostic/Automatic (MADAR) Test
334	Temperature Incorrect
374	Internal Failure
383	Lock on Malfunction
472	Fuse Blown or Defective Circuit Protector
583	Scope Presentation Incorrect or Faulty
601	Detonation
607	No-Go Indication - Specific Reason Unknown
615	Shorted
622	Wet/Condensation
631	Bias Voltage Incorrect
635	Sensitivity Incorrect
649	Sweep Malfunction
652	Automatic Align Time Excessive
653	Ground Speed Error Excessive
654	Terminal Error — CEP Excessive
655	Terminal Error — Range Excessive

656	Terminal Error — Azimuth Excessive
657	Distance Measurement Error — Navigation Equipment
658	Bearing Destination (Station) Error
660	Stripped
693	Audio Faulty
694	Audio and Video Faulty
695	Sync Absent or Incorrect
710	Bearing Failure or Faulty
711	Improper Blanking
718	Improper Response to Mechanical Input
721	Improper Response to Electrical Input
730	Loose
748	Frequency Erratic or Incorrect
780	Bent, Buckled, Collapsed, Dented, Distorted or Twisted
799	No Defect
800	No Defect — Component Removed and/or Reinstalled to Facilitate Other Maintenance
812	No Defect — Indicated Defect Caused by Associated Equipment Malfunction
900	Burned or Overheated
901	Intermittent
910	Chipped
941	Nonprogrammed Halt
943	Data Error
944	Parity Error
946	Incorrect or No Print Out
949	Computer Memory Error/Defect
956	Abnormal Function of Computer Mechanical Equipment
957	No Display
958	Incorrect Display
961	High Anode Current
962	Low Power — Electronic
963	Broken Filament/Cathode Terminal

APPENDIX F

1979 DATA RECORDS

NOTE:

These data were obtained by the survey team from Base Level Inquiry System (BLIS) computer files at each of the designated Air Force bases.

APPENDIX F – 1979 DATA RECORDS/SURVEY TEAM

Base "A"				0-Level	I-Level
Aircraft	Equipment	WUC	Item	LRUs Removed	Total URs
KC-135	ARC-164 UHF Radio	63RAO	RCVR/XMTR RT-1145	23	0
KC-135	ARC-164 UHF Radio	63SAO	Control Unit	12	2
			Total:	35	2
KC-135	ARN-118 TACAN	71ZAO	RCVR/XMTR RT-1159/A	5	1
KC-135	ARN-118 TACAN	71ZBO	D/A Converter MX-9577/A	4	1
KC-135	ARN-118 TACAN	71ZDO	Control Unit	4	0
			Total:	13	2
B-52D	ARC-164 UHF Radio	63EAO	RCVR/XMTR RT-1145	52	6
B-52D	ARC-164 UHF Radio	63EBO	Control Unit	40	11
			Total:	92	17
B-52D	ARN-118 TACAN	71ZAO	RCVR/XMTR RT-1159A	29	10
B-52D	ARN-118 TACAN	71ZBO	D/A Converter MX-9577/A	25	14
B-52D	ARN-118 TACAN	71ZDO	Control Unit	8	1
			Total:	62	25

(Appendix F, continued)

Base "B"				0-Level	I-Level
Aircraft	Equipment	WUC	Item	LRUs Removed	Total URs
A-10A	ARC-164 UHF Radio	63AAO	RCVR/XMTR RT-1168	73	22
			Total:	73	22
A-10A	ARN-118 TACAN	71ZAO	RCVR/XMTR RT-1159/A	19	13
A-10A	ARN-118 TACAN	71ZBO	D/A Converter MX-9577/A	12	8
A-10A	ARN-118 TACAN	71ZCO	Mount	1	0
A-10A	ARN-118 TACAN	71ZDO	Control Unit	14	6
			Total:	46	27

(Appendix F, continued)

Base "C"				0-Level	I-Level
Aircraft	Equipment	WUC	Item	LRUs Removed	Total URs
F-15A	ARN-118 TACAN	71ZAO	RCVR/XMTR RT-1159/A	26	5
F-15A	ARN-118 TACAN	71ZFO	Adapter Mount	14	6
F-15A	ARN-118 TACAN	63SDO	Control Unit	12	0
			Total:	52	11
F-15A	APX-101 IFF	65AAO	RCVR/XMTR	78	8
			Total:	78	8
F-15A	APG-63 Radar	74FQO	Data Processor	125	95
			Total:	125	95
F-15A	ARC-164 UHF Radio	63ATO	RCVR/XMTR RT-1145	21	1
F-15A	ARC-164 UHF Radio	63BAO	Control Unit	21	14
			Total:	42	15

(Appendix F, continued)

Base "D"				0-Level	I-Level
Aircraft	Equipment	WUC	Item	LRUs Removed	Total URs
AC-130H	ARN-118 TACAN	71ZAO	RCVR/XMTR RT-1159/A	4	0
AC-130H	ARN-118 TACAN	71ZBO	D/A Converter MX-9577/A	3	0
AC-130H	ARN-118 TACAN	71ZCO	Mount	2	0
AC-130H	ARN-118 TACAN	71ZDO	Control Unit	1	0
			Total:	10	0
AC-130H	ASN-90 INS	72TAO	Inertial Measurement Unit	17	1
AC-130H	ASN-90 INS	72TBO	Power Supply Adapter	24	0
			Total:	41	1
AC-130H	ARC-164 UHF Radio	63AAA	RCVR/XMTR RT-1145	21	7
AC-130H	ARC-164 UHF Radio	63AAO	RCVR/XMTR RT-1168	0	0
AC-130H	ARC-164 UHF Radio	63FAA	Control Unit	1	1
			Total:	22	8

(Appendix F, continued)

Base "E"				0-Level	I-Level
Aircraft	Equipment	WUC	Item	LRUs Removed	Total URs
A-7D	ASN-90 INS	73FAO	Inertial Measurement Unit	280	219
A-7D	ASN-90 INS	73FCO	IMS Control	25	3
A-7D	ASN-90 INS	73FDO	Power Supply Adapter	249	143
			Total:	554	365
A-7D	ARC-164 UHF Radio	63CAO	RCVR/XMTR RT-1145	37	8
A-7D	ARC-164 UHF Radio	63CBO	Control Unit	8	0
			Total:	45	8
A-7D	ARN-118 TACAN	71ZAO	RCVR/XMTR RT-1159/A	30	17
A-7D	ARN-118 TACAN	71ZBO	D/A Converter MX-9577/A	13	4
A-7D	ARN-118 TACAN	71ZCO	Mount	5	0
A-7D	ARN-118 TACAN	71ZDO	Control Unit	19	12
			Total:	67	33

(Appendix F, continued)

Base "F"				0-Level	I-Level
Aircraft	Equipment	WUC	Item	LRUs Removed	Total URs
F-15A	APX-101 IFF	65AAO	RCVR/XMTR	46	11
F-15A	APX-101 IFF	65ABO	XPDR/CMPTR	29	7
			Total:	75	18
F-15A	APG-63 Radar	74FQO	Data Processor	193	90
			Total:	193	90
F-15A	ARC-164 UHF Radio	63ATO	RCVR/XMTR RT-1145	13	1
			Total:	13	1
F-15A	ARN-118 TACAN	71ZAO	RCVR/XMTR RT-1159/A	10	8
			Total:	10	8
T-38	ARC-164 UHF Radio	63BBO	RCVR/XMTR RT-1168	90	35
T-38	ARC-164 UHF Radio	63BCC	Control Unit	–	–
			Total:	90	35
T-38	ARN-118 TACAN	71ZAO	RCVR/XMTR RT-1159/A	8	10
T-38	ARN-118 TACAN	71ZBO	D/A Converter MX-9577/A	2	11
T-38	ARN-118 TACAN	71ZCO	Mount	4	8
T-38	ARN-118 TACAN	71CDO	Control Unit	0	10
			Total:	14	39

(Appendix F, continued)

Base "G"				0-Level	I-Level
Aircraft	Equipment	WUC	Item	LRUs Removed	Total URs
F-15A	APX-101 IFF	65AAO	RCVR/XMTR	117	29
F-15A	APX-101 IFF	65ABO	XPDR/CMPTR	34	1
			Total:	151	30
F-15A	APG-63 Radar	74FQO	Data Processor	157	58
			Total:	157	58

(Appendix F, continued)

Base "H"				0-Level	I-Level
Aircraft	Equipment	WUC	Item	LRUs Removed	Total URs
F-111E	ARN-118 TACAN	71ZAO	RCVR/XMTR RT-1159/A	–	–
F-111E	ARN-118 TACAN	71ZBO	D/A Converter MX-9577/A	–	–
			Total:	–	–
F-111E	APN-167 Radar Altimeter	73CAO	RCVR/XMTR	–	–
F-111E	APN-167 Radar Altimeter	73CAP	Indicator	–	–
			Total:	–	–
F-111E	ARC-164 UHF Radio	63BAO	RCVR/XMTR	–	–
			Total:	–	–

(Appendix F, continued)

Base "I"				0-Level	I-Level
Aircraft	Equipment	WUC	Item	LRUs Removed	Total URs
F-15A	APX-101 IFF	65AAO	RCVR/XMTR	13	6
			Total:	13	6
F-15A	APG-63 Radar	74FQO	Data Processor	33	23
			Total:	33	23
A-10A	ARC-164 UHF Radio	63AAO	RCVR/XMTR RT-1168	18	2
			Total:	18	2
A-10A	ARN-118 TACAN	71ZAO	RCVR/XMTR RT-1159/A	9	6
A-10A	ARN-118 TACAN	71ZBO	D/A Converter MX-9577/A	1	2
A-10A	ARN-118 TACAN	71ZCO	Mount	1	0
A-10A	ARN-118 TACAN	71ZDO	Control Unit	–	–
			Total:	11	8
F-5E	ARC-164 UHF Radio	63EAA	RCVR/XMTR RT-1168	53	13
			Total:	53	13

(Appendix F, continued)

Base "J"				0-Level	I-Level
Aircraft	Equipment	WUC	Item	LRUs Removed	Total URs
FB-111A	APN-167 Radar Altimeter	73CAO	RCVR/XMTR	155	15
FB-111A	APN-167 Radar Altimeter	73CAP	Indicator	47	6
			Total:	202	21
KC-135	ARC-164 UHF Radio	63RAO	RCVR/XMTR RT-1145	21	1
KC-135	ARC-164 UHF Radio	63RBO	Control Unit	–	–
			Total:	21	1
KC-135	ARN-118 TACAN	71ZAO	RCVR/XMTR RT-1159/A	2	0
KC-135	ARN-118 TACAN	71ZBO	D/A Converter MX-9577/A	1	0
KC-135	ARN-118 TACAN	71ZCO	Mount	–	–
KC-135	ARN-118 TACAN	71ZDO	Control Unit	2	0
			Total:	5	0

(Appendix F, continued)

Base "K"				0-Level	I-Level
Aircraft	Equipment	WUC	Item	LRUs Removed	Total URs
T-38	ARC-164 UHF Radio	63BBO	RCVR/XMTR RT-1168	27	7
			Total:	27	7
T-38	ARN-118 TACAN	71ZAO	RCVR/XMTR RT-1159/A	14	4
T-38	ARN-118 TACAN	71ZBO	D/A Converter MX-9577/A	5	1
T-38	ARN-118 TACAN	71ZCO	Mount	8	3
T-38	ARN-118 TACAN	71ZDO	Control Unit	11	1
			Total:	38	9

(Appendix F, continued)

Base "L"				0-Level	I-Level
Aircraft	Equipment	WUC	Item	LRUs Removed	Total URs
T-38	ARC-164 UHF Radio	63BBO	RCVR/XMTR RT-1168	82	30
T-38	ARC-164 UHF Radio	63BCC	Control Unit	3	0
			Total:	85	30
T-38	ARN-118 TACAN	71ZAO	RCVR/XMTR RT-1159/A	18	5
T-38	ARN-118 TACAN	71ZBO	D/A Converter MX-9577/A	5	2
T-38	ARN-118 TACAN	71ZCO	Mount	1	0
T-38	ARN-118 TACAN	71ZDO	Control Unit	21	3
			Total:	45	10
F-5E	ARC-164 UHF Radio	63EAA	RCVR/XMTR RT-1168	1	0
			Total:	1	0

APPENDIX G

SUMMARY OF FIELD SURVEY REPORT ANALYSIS

APPENDIX G SUMMARY OF FIELD SURVEY REPORT ANALYSIS

Incident Data: Equipment	AFB	A/C	Page No	Total URs	Total Causes	1 Ineffective BIT: J	1 Alloc URs	2 Ineffective T.O.s: J	2 Alloc URs	3 Test Equip Differences: J	3 Alloc URs	4 Ineffective Missing Test Equipment: J	4 Alloc URs	5 Inadequate Skill: J	5 Alloc URs	6 Ineffective Supervision Support: J	6 Alloc URs	7 Management Directive: J	7 Alloc URs	8 Inadequate Feedback: J	8 Alloc URs	9 Inaccessibility: J	9 Alloc URs	Totals By Equipment: J	Totals By Equipment: URs
ASN 90	D	AC 130H	B 13	1	3	1/3	1/3					1/3	1/3									1/3	1/3		
	E	A 7D	B 15	365	3			1/3	121 2/3			1/3	121 2/3									1/3	121 2/3		
																								2	366
APN 167	J	FB 111A	B 34	21	1	1	21																	1	21
APX 101	C	F 15A	B 9	8	1	1	8																		
	F	F 15A	B 18	18	1	1	18																		
	G	F 15A	B 24	30	3	1/3	10					1/3	10	1/3	10										
	I	F 15A	B 29	6	2	1/2	3									1/2	3								
																								4	62
APG-63 (RDP)	C	F 15A	B 10	95	2	1/2	47 1/2			1/2	47 1/2														
	F	F 15A	B 19	90	3	1/3	30							1/3	30	1/3	30								
	G	F 15A	B 25	58	3	1/3	19 1/3			1/3	19 1/3					1/3	19 1/3								
	I	F 15A	B 30	23	1	1	23																		
																								4	266
ARN 118	A	KC 135	B 3	2	1							1	2												
	A	B-52D	B-5	25	1							1	25												
	B	A 10A	B 7	27	2							1/2	13 1/2							1/2	13 1/2				
	C	F 15A	B 8	11	2	1/2	5 1/2									1/2	5 1/2								
	D	AC 130H	B 12	0(1)	1	1	0(1)																		
	E	A 7D	B 17	33	2	1/2	16 1/2									1/2	16 1/2								
	F	F 15A	B 21	8	1	1	8																		
	F	T 38	B 23	P/D	2	1/2	P/D					1/2	P/D												
	H	F-111E	B 26	N/D	1											1	N/D								
	I	A-10A	B-32	8	1	1	8																		
	J	KC-135	B-36	0(1)	1	1	0(1)																		
	K	T 38	B 38	9	2							1/2	4 1/2					1/2	4 1/2						
	L	T 38	B-41	10	2	1/2	5											1/2	5						
																								13	133
ARC 164	A	KC 135	B-2	2	1											1	2								
	A	B-52D	B-4	17	3			1/3	5 2/3					1/3	5 2/3	1/3	5 2/3								
	B	A 10A	B-6	22	1											1	22								
	C	F 15A	B-11	15	1													1	15						
	D	AC 130H	B 14	7	1													1	7						
	E	A 7D	B 16	8	1											1	8								
	F	F 15A	B 20	1	1													1	1						
	F	T 38	B 22	35	1											1	35								
	H	F 111E	B 28	N/D	1											1	N/D								
	I	A 10A	B 31	2	1											1	2								
	I	F 5E	B-33	13	1											1	13								
	J	KC 135	B 35	1	1											[illegible]	[illegible]								
	K	T-38	B 37	7	1													[illegible]	[illegible]						
	L	F 5E	B 39	0(1)	1													1	0						
	L	T 38	B-40	30	1													[illegible]	[illegible]						
																								15	160
Totals By Cause Category						12 1/3	223 1/6	2/3	127 1/3	5/6	66 5/6	4 1/2	177	1	45 2/3	11 1/2	163	7	69 1/2	1/2	[illegible]	2/3	122	[illegible]	1008
Percentage (Of Grand Total)						32	22	2	13	2	7	12	18	3	5	29	16	18	[illegible]	1	1	2	12	100(+)	100
Totals By Cause Category Less ASN 90 Contribution						12	222 5/6	1/3	5 2/3	5/6	66 5/6	3 5/6	55	1	45 2/3	11 1/2	163	7	69 1/2	1/2	[illegible]	0	0	[illegible]	642
Percentage (Of Corresponding Grand Total)						32	35	1	1	2	10	10	9	3	7	31	25	19	11	1	2	0	0	100	100

Notes: [illegible]
N/D No Data
(1) No Reported URs
J Judgments weighted [illegible]
*Numbered in accordance with the listing [illegible]

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